# Nature

A WEEKLY

## ILLUSTRATED JOURNAL OF SCIENCE

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"*To the solid ground*
*Of Nature trusts the mind which builds for aye.*"—WORDSWORTH



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## Reviews and Our Bookshelf.

# NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
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THURSDAY, MAY 7, 1908.

## *LA HOUILLE BLANCHE.*

*Service d'Études des grandes Forces hydrauliques (Région des Alpes), Annales de la Direction de l'Hydraulique.* In two volumes. Vol. i., pp. 181; vol. ii., pp. 451; with maps and diagrams. (Paris: Imprimerie nationale.)

MOUNTAINOUS countries are ill adapted for convenience in travel and transport, but as some compensation for this drawback, Nature has endowed them with a signal benefit of another and equally important kind. She has placed at the disposal of the inhabitants a form of energy which is not only readily utilisable, but in the majority of instances is cheap and plentiful, and, it may be added, is also picturesque. The numerous streams of water which streak the mountain sides like veins of silver ore, or which

"like a downward smoke,
Slow dropping veils of thinnest lawn,"

spread themselves over the ledges of precipitous cliffs, possess a wonderful commercial value. They are, indeed, to be reckoned among the most utilitarian assets and resources of a country, side by side with coal, iron, and other such serviceable minerals, while they possess the additional advantage that their application to industrial purposes is readily effected, and is almost as unlimited in scope as the supply is, apparently, inexhaustible. The French have poetically referred to the latent wealth of these mountain streams as *la houille blanche* (white coal), and coal they surely are, to all intents and purposes, for when diverted into proper channels, do they not serve to actuate wheels and vanes, motors and turbines, setting in useful motion a wide range of plant and machinery as effectively as coal itself, without the complicated series of transformations required before the latter is converted into horse-power units?

The study, then, of so valuable a source of industrial energy is almost an obvious duty on the part of the countries thus enriched. Not until within the last fifteen or twenty years, however, has this duty become definitely recognised as a national obligation deserving of governmental support. At the present time in France, Switzerland, and Italy, three countries enclosing or bordered by lofty mountain ranges, there are organised commissions, subsidised by their respective Governments, for the purpose of collecting data and establishing records of the various changes in flow and level of mountain streams.

In Italy the initiation of systematic hydrographical research dates from 1890, when Zoppi was commissioned to study successively the Aniene, the Nera, the Velino, and their principal affluents. The Swiss hydrographical service was inaugurated by a federal decree of 1895. France did not recognise her obligation until eight years later, and the first of the two volumes under consideration opens with an account of how an instruction of the Minister of Agriculture, dated March 25, 1903, set upon a proper footing the study of questions affecting the assessment of hydraulic power in mountainous regions and the utilisation of the energy therein contained by the regulation of channels or of the water itself.

The hydrological service thus established was first allocated to the Alps, to be extended later to the Pyrenees, and ultimately, if it be considered desirable, to the whole country. Its programme comprises, first, the purely physical investigation of watercourses and their basins from a geographical, meteorological, and hydrographical point of view; and, secondly, the economical study of questions involved in the utilisation of the energy produced.

The first part of vol. i. is devoted to an account of the steps taken and the results achieved during the first year, or rather during the whole period prior to 1904. There is some reference to early attempts at gauging the Isère and the Durance, and a deduction, from these and similar experiences, of methods advisable to be pursued in the future.

Then follows a detailed account of the observations made and recorded during the years 1904 and 1905. Both this and the preceding section are arranged on common lines, and the subject is treated under several heads, comprising:—

(1) General organisation and programme of work.

(2) Gauging stations; methods adopted for measuring the discharge of streams.

(3) Pluviometry, nivometry, and glacial studies.

(4) Planimetry; surface measurement of basins.

(5) Levelling; determination of slope and fall.

(6) Publication of results.

The records are very full and complete. They abound in instances of local difficulties and the manner in which these were overcome. The work was carried out under the joint direction of M. de la Brosse and M. Tavernier. The former gentleman concerned himself more particularly with the basins of the Arve and the Isère, and the latter with the basins of the Durance and the Var.

There are a large number of appendices dealing with various matters of special interest, including some practical directions in the matter of gauge measurement, a note on the theory of screw calibration, a provisional estimate of the value of the hydraulic forces, a typical hydrological study of a mountain basin, and other cognate matters of importance.

The theoretical and mathematical investigations are of an extended and detailed character, and the volume forms a thoroughly complete and valuable guide for those who are engaged in hydrographical studies and experiments. A number of interesting photographs are reproduced, showing the actual operation of gauging as carried out at several places, and illustrating in a most effective manner the expedients described in the text for dealing with particularly difficult and almost inaccessible stations.

It is recorded that a good deal of very useful assistance was derived from voluntary workers, including those at power stations and industrial depôts. Help was also forthcoming from officers at military posts and from the staff of the conservators of waters and forests. Aid was rendered, too, by meteorological and geological departments, municipal and vicinal administrations, and by railway companies, notably the Paris-Lyon-Méditerranée. The coordination and instruction of all these various agencies, spread over an extended area, involved much care and attention.

The second volume is devoted almost entirely to a numerical record of the results of the work. It abounds in figures and data systematically collated and arranged, so as to be of immense value for reference purposes. It also includes a series of excellent maps of the various basins printed in colours, showing the subsidiary watersheds, and indicating the positions of the stations of observation. Altogether, the volumes are replete with information, and form a striking testimonial to the value and national utility of the Service d'Études des grandes Forces hydrauliques.

## SUBTERRANEAN STUDIES.

*L'Évolution souterraine.* By E. A. Martel. Pp. 388; with 80 figures. (Paris: Ernest Flammarion, 1908.) Price 3.50 francs.

IN France, the fascinating study of caverns—or, as it is now the fashion to call it, spelæology—has risen greatly in popular favour during the last twenty years, mainly through the energy and enthusiasm of M. Martel, one of the editors of *La Nature*. The scope of spelæology, in the course of its recent development, has become gradually enlarged until it now touches at one point or another almost the entire circle of the sciences. The work before us, which forms a volume of Dr. Gustave Le Bon's "Bibliothèque de Philosophie scientifique," extends, however, beyond the mere study of caves, though this forms its main theme. From caverns the author passes to the general phenomena of the underground world, and seeks to show how their study has a bearing on nearly all branches of knowledge, especially on the doctrine of evolution. The range of the work consequently comes to be extremely wide. Where the programme set before the writer is so ambitious, no reasonable reader can expect to find it worked out with thoroughness. Brevity often becomes imperative. The wonder is not that many of the subjects are touched with only a light hand; the wonder is rather that it has been found possible to crowd so much into a volume of such limited size.

Scattered through M. Martel's pages are many suggestions which seem to call for remark. Thus, with regard to the planes of rupture in the earth's crust, he suggests that the term "joint" should be limited to planes of stratification, whilst those fissures which run vertically or obliquely, and in stratified rocks across the bedding, should be called "diaclases"—one of the terms introduced by Daubrée in his system of nomenclature for divisional planes. No doubt it would be convenient to have some short word for a plane of bedding, but it will certainly require much persuasion to induce an English geologist to call it a joint, for this happens to be just the term that he is in the habit of applying to any plane other than that of stratification.

Our author does well to insist on the fact that the process of cave-making, so far from being due to a single agent, depends in most cases partly on mechanical erosion and partly on chemical corrosion. Which of the two processes is the more important is determined to a large extent by the character of the rock to be hollowed out. Moreover, the formation of these subterranean hollows has not been limited, as some Continental writers have supposed, to any particular geological epoch.

On the question of the supposed desiccation of the earth—a subject on which so much has been written—M. Martel holds very pronounced views. Whilst some writers who admit the progressive diminution of the earth's superficial waters believe that it proceeds too slowly to be recognised in historic time, our author holds that abundant evidence of the change may be cited within the range of human history. On the other hand, a compensating action may come into play if it be true, according to an opinion that has recently been gaining ground in certain quarters, that much of the water emitted as vapour by volcanoes is derived from the deep-seated magma of which it is an original constituent, so that its emission is a direct contribution to the surface-waters of the globe.

It was only to be expected that M. Martel would have much of interest to say on his favourite subject of the hygiene of potable waters. Those who are acquainted with his former writings will not be surprised at his warning that springs of apparently pure water are in many cases merely the outflow of surface-waters which have disappeared through fissures, carrying with them pollution from the soil and not undergoing purification during their passage through the rocks. Even chalk, according to the writer, is generally far from being a thoroughly effectual filter.

In glancing through M. Martel's work the reader will find, probably to his surprise, that the spelæologist is unquestionably a being of large discourse, looking before and after. In one part he discusses the origin of man and the cradle of his civilisation; in another he speculates on the probable future of humanity; in an early chapter he discourses on the hypotheses concerning the beginning of the earth; in the last chapter he carries the reader forward to the catastrophes likely to bring the history of our planet to a close. Notwithstanding the fact that the range of subjects is thus so wide and diverse, the book remains readable and informing throughout. M. Martel is always vivacious, sometimes impressive, and occasionally original—but never obscure. In fine, he has written a little book which may be described in the best sense of the word as popular.

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## *CHEMISTRY OF PHARMACOLOGY.*

*The Chemical Basis of Pharmacology.* By Francis Francis and J. M. Fortescue-Brickdale. Pp. xii + 372. (London: E. Arnold, 1908.) Price 14*s.* net.

THE general scope of this work is indicated by the above title and the subtitle, reading "An Introduction to Pharmacodynamics based on the Study of the Carbon Compounds." Short general introductions to chemistry and physiology are first given, dealing with such subjects as valency, structural formulæ, isomerism, correlation of chemical and physiological properties, and the relationships between structure and action. Then follow chapters on the main groups of carbon compounds, for example, hydrocarbons, alcohols, purine bodies, and the alkaloids, their methods of preparation and properties, both chemical and physiological. The book contains a fund of information, from which many suggestions as to lines of research may be gathered, and is a genuine attempt to systematise our present knowledge of the chemistry of pharmacology. As such it should prove of great use, more particularly to physiological and pharmaceutical chemists rather than "to the practitioner who is daily brought in contact with the claims of new drugs," and whose chemical knowledge could hardly be expected to reach the standard required for the assimilation of the information given, however desirable such a state of things might be.

We agree with the authors that the student of organic chemistry will find in the work an introduction to a fascinating branch of applied chemistry, but think that the usefulness of the book, alike to the student of chemistry and manufacturer of synthetic drugs, would have been largely increased had more references to original papers been given. It is also to be regretted that more care has not been bestowed on the book during its passage through the press. The orthography is sometimes unusual in such words as "etherial," "radical," "Kekule," and the work contains innumerable press errors, and many which cannot be attributed to this cause. For example, the expression (p. 90)

$$C_2H_5.OH + HNO_2 = H_2O + C_2H_5ONO2 \text{ (Ethyl nitrite)}$$

is not an equation, nor is the formula for ethyl nitrite correct. Butyl chloral (pp. 79, 109) has not the formula $CCl_3.CH_2.CHO$, and trichloroethyl alcohol is not accurately represented as $CCl_3.COH$. Such faults are inexcusable.

A very deplorable aspect of modern chemistry in its application to pharmacy or physiology would appear to be the lack of system in nomenclature, and a consequent flood of synonyms. This point does not seem to have appealed to the authors, for we find them either ignorant of, or not in agreement with, the systems of nomenclature adopted by the Physiological and Chemical Societies, and in consequence confusion is rendered worse confounded by the adoption of any and every style of naming. We quote as examples "proteid or protein"; "methyl or methylic alcohol"; "sodic or sodium acetate"; "silver hydrate, aqueous potash, ammonium hydroxide"; "glycerol or glycerin"; "mannite or mannitol"; "oxybenzoic or hydroxybenzoic acid"; and "1-oxy-2-iodo-4-chlor-quinoline."

It could reasonably have been expected that the authors would have made a serious attempt to introduce order and method where chaos prevails by adhering strictly to those generally accepted principles of nomenclature which, though imperfect, materially help to build up an intelligible chemical literature.

A. C.

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## *TWO RECENT BOOKS ON EVOLUTION.*

(1) *A Picture Book of Evolution.* By Dennis Hird. Part ii. Pp. vi + 214. (London: Watts and Co., 1907.) Price 2*s.* 6*d.* net.

(2) *Darwinism To-day.* By Prof. V. L. Kellogg. Pp. xiv + 403. (London: George Bell and Sons; New York: Henry Holt and Co, 1907.) Price 7*s.* 6*d.* net.

WE cannot recommend anyone wishing to make himself acquainted with the present aspect of the problem of evolution to put himself under Mr. Hird's guidance. His treatment of the subject is crude and uncritical, nor does he give any evidence of familiarity with the evolutionary questions that are now chiefly engaging the attention of biologists. Putting minor inaccuracies aside, the book might have been of some service if published, say, forty years ago; at the present time it is to a large extent either misleading or superfluous. Opposition to the doctrine of species-formation by natural selection comes to-day, not, as the author seems to think (p. 25), from the "House of Lords or the pulpit," but from scientific men, both in this country and abroad; more particularly in Germany and America. While no educated person now disputes the fact of evolution, the Darwinian theory is being attacked more vigorously than ever; the assailants, however, belong to a very different class from Darwin's impetuous critics of the early 'sixties. Mr. Hird takes little or no notice of present-day problems, but writes as if the whole question of evolution still occupied the same position as in the mid-Victorian era. Within these limits he is fairly interesting; it is, however, unfortunate that he has admitted to his pages several inaccuracies that might with a little more care have been avoided. "Oasperm," "octoderm," are ugly misprints; "hermaphrodite" does not mean the same as "diœcious"; it is new to us that hæmatococcus "like the amœba, requires to be magnified some 900 times in order to be seen." Huxley can scarcely be ranked as a "discoverer of evolution"; he would certainly never have made such a claim for himself. The illustrations in Mr. Hird's volume have mostly been seen before. Many of them are good, but the connection of some with the text is remote.

(2) Prof. Kellogg's book is of a very different stamp. So far from ignoring the questions that have in recent years grown up around the central doctrine of evolution, he has devoted an immense amount of labour to collecting, arranging, and expounding the views of nearly all the recent writers on evolutionary subjects. His treatise thus contains a vast quantity of material, in large part consisting of copious quotations from English, French, and German authors, put together somewhat promiscuously, and discussed without much exercise of the critical faculty, but useful to the student as a storehouse of various and conflicting opinions. The author's own standpoint is not very easily discovered. He passes in review the tenets of Darwinians, Lamarckians, Mutationists, Nägelians, with much appearance of giving a fair hearing to all sides. But as he seldom seems to know his own mind for long together, the general result is unsatisfying, not to say irritating; his impartiality is the impartiality of the pendulum rather than that of the judge. The author rightly appreciates the constructive weakness of anti-Darwinian arguments, but greatly overestimates their destructive efficiency. He allows, for example, far too much weight to frivolous objections such as those raised by Wolff in his "Beiträge zur Kritik der darwin'schen Lehre."

In examining the assaults delivered from various quarters on the Darwinian position, one cannot help being struck with the fact that the efforts of objectors tend much more effectively, on the whole, to refute each other than to weaken the defence. It is also quite obvious that to many of these critics Darwin's own writings are practically a sealed book. One cannot suspect Prof. Kellogg of talking about Darwin without having read him; nevertheless he shows, like other writers, a strange confusion of mind with respect to the Darwinian view of the function of natural selection in evolutionary process. Why should it be considered a "weakness" of the Darwinian theory of natural selection that this principle has "no influence whatever on the origin and control of variations"? Darwinism never professed to be an "all-sufficient explanation of adaptation and species-forming" apart from the existence of variation, which fact it takes for granted. It is irrational to blame a theory because it does not explain one of the fundamental data from which it starts.

In at least one passage of his book, the author shows a distinct leaning towards the "orthogenesis" advocated by the school of Eimer. Theories, he thinks, of this general type "are directly in line with the spirit of modern biological methods and investigations." On this point, opinions will differ; we should be inclined to maintain the opposite. On a later page he advances what he considers to be "a logical proof for the introduction into phylogeny of adaptive ontogenetic changes," *i.e.* a proof of Lamarckism, for it is hard to see any distinction between this view and that of the French evolutionist.

"When species-differences and adaptations are identical with differences and modifications readily directly producible in the individual by varying environment, are we not justified," he asks, "on the basis of logical deduction, to assume the transmutation of ontogenetic acquirements into phyletic acquirements, even though we are as yet ignorant of the physicochemical or vital mechanism capable of effecting the carrying over?"

This question we should unhesitatingly answer in the negative. When rhetoric of the above description is dignified with the name of "proof," we are not surprised to find that the author's estimate of the true bearing of ascertained facts is feeble. It appears to cause him some astonishment that there still exist, "especially in England," thorough-going Darwinians who remain unmoved by the storm of criticism levelled against the theory of natural selection. That there are such stalwarts is undoubtedly the case, and the situation as maintained by them could not be better expressed than in the words, quoted without approval by Prof. Kellogg, of Sir E. Ray Lankester, at York, in August, 1906:—

"In looking back over twenty-five years it seems to me that we must say that the conclusions of Darwin as to the origin of species by the survival of selected races in the struggle for existence are more firmly established than ever."

F. A. D.

## OUR BOOK SHELF.

*Graphics, applied to Arithmetic, Mensuration, and Statics.* By G. C. Turner. Pp. ix + 388. (London: Macmillan and Co., Ltd., 1908.) Price 6s.

THIS work forms a valuable addition to the text-books on an important branch of mathematics, and, coming from a past student of Prof. Henrici, is especially welcome. Within the limits imposed by the author, the subject of graphics is very fully and ably treated. The first chapter, on graphical arithmetic, gives, at perhaps undue length, the geometrical constructions corresponding to the ordinary arithmetical processes, with the employment of scales and squared paper, and is followed by a very useful chapter on the graphical mensuration of plane figures. Vectors are then introduced, with examples of displacement, velocity, and acceleration vectors, and problems on mass centres—altogether a very interesting section. Experimental work is done in connection with concurrent forces in chapter iv., and in verification of the properties of the link polygon and the equilibrium of a general system of coplanar forces in chapter v.

The principles of graphic statics, having thus been well laid and amply illustrated, are further developed in the succeeding chapters by practical applications, such as to stress diagrams for bridge and roof trusses, loaded at the joints, at intermediate points, and under wind pressures; to bending moments and shearing forces in beams, and the action of travelling loads; and to problems involving friction and work done by constant and variable forces.

While the deductive reasoning is well sustained throughout and satisfying to the logician, the subject is everywhere exemplified by concrete examples, fully worked out, and at short stages the student is provided with exercises in abundance, with answers, the author having drawn freely from the examination papers of the University of London, the Board of Education, the Civil Service Commission, and similar sources.

The very fulness with which graphic statics is discussed and illustrated in this volume makes one regret that some space could not have been found (by omissions, if necessary) for the equally important subject of graphic dynamics, founded on the vector conception of Newton's second law, with the application of the hodograph, and illustrations drawn from the motions of machines, the leading idea being to develop the fundamental law that force is vector rate of change of momentum. The author rightly emphasises the need for good-sized figures, and uses fairly large set-squares, in conjunction with straight-edge, scale and compasses, but he seems content with this comparatively meagre equipment, the incompleteness of which must surely handicap a student who does much quantitative graphical work.

With these reservations the book is admirable, and should do much to encourage the teaching of a subject that ought to form an integral part of the mathematical training given in our secondary and technical schools.

*Man and his Future: A Glimpse from the Fields of Science.* By Lt.-Col. William Sedgwick. Pp. 256. (London: T. Werner Laurie, 1907.) Price 7s. 6d. net.

This book is a curiously naïve attempt to justify and interpret in the light of modern scientific discoveries a somewhat old-fashioned form of orthodoxy. "The whole universe is the scene of a conflict between two powers over the possession of atoms of matter." This conflict is waged by means of the $\alpha$- and $\beta$-rays of the physicist, which have respectively the power of "doing building work" with the atoms and of destroying the systems thus set up. Man is "a transgressing anthropoid ape" who, having wandered out of the regions where alone he could live in a state of nature, has purchased relief from his conditions by taking service with the Power of Repulsion destroying the forests of the earth for fuel, and analysing compounds (such as ores) for their useful elements. But the growth of his needs has led him from mere destruction to synthesis, and so into the service of the Power of Attraction. Nevertheless, his original transgression condemns him still to destroy on earth, so that his synthetic activities—shown, for example, in chemistry, physics, and engineering—must be regarded as really "a training in the art of Universe-building," to be applied seriously only when the present cosmic order makes way for the New Evolution. Thus death is "a recruiting agency for the staff" to be engaged upon this gigantic re-constructive operation, when they have re-clothed their "resting forms" in the protoplasmic garments for which the coal seams and the nitrate beds are perhaps intended to provide materials.

This work is so sincerely and modestly written that one regrets the necessity of saying that it can have but little value except to the student of the psychological history of discovery, who will note with interest and curiosity that, in connection with his "building-up" theory, Col. Sedgwick, in 1902, predicted the existence of non-valent elements having the atomic weights now actually assigned to the members of the helium group.

*Développement et Progrès de la Fabrication du Malt pendant les quarante dernières Années.* By Ed. Eckenstein. Pp. 212. (Paris: A. Hermann, 1908.) Price 5 francs.

This work gives an account of the development of methods of malting on the Continent from the time when the employment of mechanical appliances to supplement hand labour was first suggested to the present day, when, in some maltings, hand labour has practically disappeared. The author makes no attempt to discuss the progress of scientific knowledge in relation to malting, but confines himself almost entirely to a description of the manner in which the engineer has overcome many of the practical difficulties met with when attempting to deal with large bulks of germinating grain other than by hand labour. Problems such as the controlling of the heat generated by respiration of germinating grain in mass, and establishing an equal distribution of moisture throughout the individual corns of the mass, together with equal conditions of aëration, have to be solved. The solution of such problems by mechanical means is not easy, and there are still many competent critics, both in this country and abroad, who consider that the claim for success made by advocates of mechanical malting is not at present thoroughly well justified. However this may be—and the question is essentially a technical one—everyone interested in the progress of mechanical malting should read M. Eckenstein's book, the value of which is much enhanced by the numerous very excellent drawings and diagrams which it contains.

*The Romance of the Sky; the Story of Star-gazing and Star-tracing, being an Introduction to the Study of Astronomy.* By C. J. Griffith. Pp. viii+166. (London: George Routledge and Sons, Ltd.; New York: E. G. Dutton and Co.)

Mr. Griffith has undertaken to tell his story through the mouth of a mythical amateur astronomer, condemned to live through all the phases of astronomical science from pre-Ptolemaic days to the present. The method naturally introduces a great deal of reading matter that is not astronomy, but for non-astronomical readers the result, thus diluted, should prove of interest. A talk with Ptolemy, the enunciation of his great theory by Copernicus himself, the unfortunate reaction which delayed astronomical progress for centuries, and the final clearing of the mists by Kepler's results, occupy the first twenty pages. Then in rapid sequence Galileo, Newton, Halley, Herschel, and other notable workers in astronomy are interviewed, the volume concluding with discourses on the making of present-day observations and the deductions arising therefrom. The book is good, in parts, and the glossary of astronomical terms (chapter xxiv.), together with the excellent index, should not prove the least interesting or instructive to the beginner.

W. E. R.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### Life on Mars.

IF the canals of Mars are structures made by intelligent beings, it is difficult to believe that these beings have not at their disposal appliances both for construction and survey. It is difficult to believe that some of these appliances are not made of metal. If made of metal, it is difficult to believe that the Martians do not use fire. There is strong evidence that friction was the source of the discovery of fire on the earth. But is it likely that fire would be discovered by friction on a planet the barometrical pressure of which is less than 4 inches of mercury, and the still atmosphere of which is believed to be free from thunderstorms and lightning flashes?

The obvious, and I think adequate, criticism of such an argument is that it is anthropomorphic. It interprets the conditions of life on Mars too much in terms of human experience. In the present state of our knowledge, may not the same criticism be made of the assertion that life on Mars is accompanied by an intelligence similar to our own? On the earth, life without any high degree of intelligence has been the rule. Life with a high degree of intelligence has been the exception, an exception confined to an insignificant fraction of the time during which mundane life has existed. Is it safe, without very cogent evidence, to assert that a similarly exceptional state of things exists on Mars? Can no other possibilities be suggested?

To be told that life exists on Mars tells us but little of its nature. It does not even tell us that living beings exist. Perhaps on Mars there is only one living being, a gigantic vegetable the branches or pseudopodia of which embrace the planet like the arms of an octopus, suck water from the melting polar snows, carry it to other parts of the planet, and are visible to us as the Martian canals. Lowell adduces the straightness of the canals as a proof that they are artificial products of intelligent beings. But they are certainly no straighter than the somewhat similarly interlaced pseudopodia seen in certain Heliozoa, Foraminifera, and Radiolaria.

That this idea is not excluded by anything necessarily inherent in the nature of living matter may be shown by considering the conditions that must have accompanied the origin of life, whether on the earth or on Mars. Parenthetically, it may be remarked that the existence of life on Mars is not without bearing on the problem of the origin of life on the earth, and Lowell's discovery may be regarded as adding reason to the hope that has been expressed that some day life may be artificially produced in our laboratories.

It is impossible to believe that life originated directly by a fortuitous concourse of atoms of the elements of which living matter consists. Organic compounds must first have come into existence as links between the living and the not living. Some clues as to the nature of these links possibly may be afforded by current researches on the fixation of atmospheric nitrogen. We may surmise that some stages in the evolution of living matter were amino-acids, polypeptids, and proteids. The fact that nowadays no such substances exist in natural water does not disprove this supposition, for had such compounds existed they must long ago have been destroyed by bacteria and similar organisms. We may surmise that gradually these primeval proteids became aggregated into larger and larger molecular complexes until they existed as a loose jelly of indefinite extent, that these complexes were subjected to a slow oxidation, that, if we may accept Pfluger's doctrine of the nature of respiration, these molecular complexes, under the influence of oxidation, acquired a certain molecular instability, but showed at first no other vital character than the power of combining with or assimilating other molecules of primeval proteid. However imperfect such a conception may be, there can be no doubt that the process of the origination of life was in the main a process of building up (one is tempted to use the word polymerisation) of small simple aggregates into larger and more complex aggregates. I can see no reason for believing that there was anything in the nature of this primitive living matter that would prevent this process of aggregation from continuing indefinitely. Or, in other words, we have no right to assert that there could have been anything in the nature of the primitive living matter itself to prevent it forming a scum of unlimited extent on the water in which it existed.

The fact that such indefinite growth either did not occur, or, if it did occur, was only a transient stage in evolution, may safely be ascribed to the effect of some external forces or conditions of the environment. An illustration may make this clear. Ice-crystals have the property of aggregating together to form snow-flakes. Owing to conditions and forces external to themselves, the process of aggregation does not continue indefinitely, but the snow-flakes cease to grow when they have reached a certain size. Under another set of conditions, ice-crystals may not form snow-flakes at all, but may cover a large extent of country in the form of hoar-frost. Similarly, the primitive living matter on the earth, owing to the action of some external forces or conditions, developed in the form of separate individuals that we may compare to snow-flakes. The possibility cannot be excluded that on Mars living matter developed in the form of a scum covering the seas of that planet, which scum would correspond to the hoar-frost of our illustration. What external force is there that would be likely to act on primitive living matter on the earth, but not on Mars? Could it be the action of tides and waves?

All I wish to assert is that it is possible and conceivable for a single vegetable organism to come into existence on a planet, and for it not to break up into separate individuals. In such a vegetable, parts unfitted for the environment might perish and be assimilated by other parts that were better adapted to the conditions that existed. Thus it might possess a power of adaptation to a changing environment, such as must have occurred, for example, in the drying up of the seas that once existed on Mars. No one who believes in "the continuity of the germ-plasm" will see any objection in the quasi-immortality of such an organism.

Another possibility may be suggested. Supposing, in the course of many millions of years, the earth was to follow the example of Mars and gradually to lose its water. Should this happen, a stage would be reached in which a few isolated lakes existed in the dried-up beds of the oceans. Let us imagine what then might be seen by an intelligent being on the planet Venus who had "an eye for planetary detail." Might he not see a system of faintly shown lines stretching from lake to lake and to the polar caps? Might they not show evidence of seasonal change? And might he not then conclude that they were canals made by beings of greater intelligence than his own, though in reality they were only fronds of a gigantic seaweed that had developed from the gigantic seaweeds that at present exist in the Sargasso Sea? Is it not likely that in the course of ages the fronds of such vegetables would contract until they formed straight lines from oasis to oasis, and so further the idea that their production was due to intelligence?

These ideas are obviously merely of the nature of suggestions, and I wish expressly to disclaim holding any definite opinion or belief as to the nature of the life on Mars. Prof. Lowell has measured the rate of flow of water in some of the Martian canals. Is this rate the "economical rate" for the flow of water along an open canal, or does it agree better with the economical rate, if the phrase is applicable, for the flow of water along pipes of a vegetable organism, where presumably the loss from percolation and evaporation would be trivial?

My position is that one may admit that Prof. Lowell's brilliant researches prove the existence of life on Mars, and still ask from him further evidence before we are convinced that that life is intelligent. E. H. HANKIN.

Agra, India.

## The Warm Stratum in the Atmosphere.

WHILE not presuming to offer an explanation of the isothermal or relatively warm stratum in the high atmosphere, which the recent letters in NATURE have made known to others than meteorologists, I desire to point out that it is probably a universal phenomenon, existing at some height all around the globe. This inversion of temperature was first discovered by M. Teisserenc de Bort with the *ballons-sondes* sent up from his observatory at Trappes, near Paris, in 1901, and almost simultaneously by Prof. Assmann from similar German observations. Since then almost all the balloons which have risen more than 40,000 feet above Central Europe (that is, near latitude 50°) have penetrated this stratum, without, however, determining its upper limit. Teisserenc de Bort early showed that its height above the earth, to the extent of 8000 feet, varied directly with the barometric pressure at the ground. Mr. Dines (NATURE, p. 390) gives the average height of the isothermal layer above England as 35,000 feet, with extremes of nearly 50 per cent. of the mean. Observations conducted last March by our indefatigable French colleague, Teisserenc de Bort, in Sweden, just within the Arctic circle, showed that the minimum temperature occurred at nearly the same height as at Trappes, namely, 36,000 feet, although Prof. Hergesell, who made use of *ballons-sondes* over the Arctic Ocean, near latitude 75° N., during the summer of 1906, concluded that the isothermal stratum there sank as low as 23,000 feet.

During the past three years the writer has dispatched seventy-seven *ballons-sondes* from St. Louis, U.S.A., latitude 38° N., and most of those which rose higher than 43,000 feet entered the inverted stratum of temperature. This was found to be somewhat lower in summer, but the following marked inversions were noted last autumn:—October 8, the minimum temperature of −90° F. occurred at 47,600 feet, whereas at the maximum altitude of 54,100 feet the temperature had risen to −72°; October 10, the lowest temperature of −80° was found at 39,700 feet, while −69° was recorded at 42,200 feet, showing a descent of nearly 8000 feet in the temperature-inversion within two days. The expedition sent out jointly by M. Teisserenc de Bort and the writer, on the former's steam yacht *Otaria*, to sound the atmosphere over the tropical Atlantic during the summer of 1906, launched *ballons-sondes* both north and south of the equator within the tropics, and although some of these balloons rose to nearly 50,000 feet, they gave no indication of an isothermal stratum. In fact, the paradoxical fact was established that in summer it is colder eight miles above the thermal equator than it is in winter at the same height in north temperate regions. This results from the more rapid decrease of temperature in the tropics and the absence of the numerous temporary inversions which, as Mr. Dines has pointed out, are common in our regions below 10,000 feet. If, therefore, as seems probable, the isothermal or relatively warm stratum does exist in the tropical and equatorial regions, it must lie at a height exceeding 50,000 feet, from which height, as the data quoted show, it gradually descends towards the Pole, at least in the northern hemisphere.

A. LAWRENCE ROTCH.

Blue Hill Meteorological Observatory, Hyde Park, Mass., U.S.A., April 24.

## The Nature of X-Rays.

PROF. BRAGG in a recent letter (NATURE, April 16) credits me with the admission that the experiments I made on the intensity of secondary (scattered) X-rays are not so contrary to the neutral pair theory as I at first supposed. Will you permit me to correct this by saying that all the evidence I have obtained has verified the ether pulse theory in a more striking way than I ever anticipated, and I cannot think of a single experimental result obtained in researches on secondary X-rays which gives any support to his theory?

Prof. Bragg refuses, on the plea of want of knowledge of the constitution of the atom, to accept as conclusive the results of experiments I recently made. It appears to me, however, that such absence of knowledge is insufficient to conceal the disproof of his theory, and that the evidence (though by itself not sufficient to establish any theory) is quite sufficient to distinguish between the ether pulse theory and that proposed by Prof. Bragg.

The supposed difficulty in accounting on the ether pulse theory for the change in the ratio of intensities, to which he refers, is not one affecting the theory at all. Sufficient experiments have not yet been made to lead to a final choice between several possible causes as producing the bulk of this effect. The result itself is in harmony with the results of other experiments.

As Prof. Bragg is apparently not convinced, I venture to recommend the consideration of the following evidence obtained in investigating secondary X-rays, for I can only think that the study of this evidence would at least lead him to confine the application of his hypothesis to the explanation of phenomena which at any rate do not furnish so striking a disproof.

The evidence may be briefly summarised as follows:—

(1) The partial polarisation of a primary beam of X-rays.

(2) The identity in penetrating power of secondary (scattered) rays from light atoms, and of the primary producing them, though the scattered constitute only a fraction of the incident rays.

(3) The equality in the proportion of rays of different penetrating power which are scattered.

(4) The fairly complete polarisation of the rays scattered in a direction perpendicular to that of propagation of the primary.

(5) The distribution of the secondary (scattered) rays.

(6) The order of magnitude of the energy of scattered radiation.

(7) The homogeneity of a second type of secondary X-radiation from many substances.

(8) The fact of this homogeneous radiation being characteristic of the element emitting it, and independent of the penetrating power of the primary radiation producing it.

(9) The fact that for large ranges in the penetrating power of the primary these homogeneous secondary rays from some substances are proportional to the ionisation produced by the complex primary in air.

These are points that occur to me while writing; there are probably others.

The first five results (though not explicitly stated) were contained in the theory as given by Prof. J. J. Thomson ("Conduction of Electricity through Gases") shortly after the publication of the second experimental result, and before the others were experimentally observed. The sixth is in harmony with the calculation given by Prof. Thomson if we accept his theory of the number of electrons in the atom. Results (7), (8), and (9), obtained in joint-work with Mr. C. A. Sadler, can be explained on the ether pulse theory.

Prof. Bragg has given an explanation (based on what seem to me doubtful assumptions as to the behaviour of a neutral pair on collision with light atoms) of the fourth result. An explanation on his theory of the other facts necessitates in some cases very improbable assumptions; in others it appears to me to lead to absolute impossibilities. In no case can I find the slightest support for the neutral pair theory.

Regarding the nature of $\gamma$ rays, or even of very penetrating X-rays, the direct evidence is much less conclusive, the corresponding phenomena being in reality more complex, for reasons which are beginning to be understood. For that reason I do not wish at present to discuss them, preferring to deal with what is to me a certainty, and waiting for the results of further experimental work to throw light on the more complex. Prof. Bragg commences at the other end with a hypothesis which gives an easy explanation of what on the pulse theory is somewhat obscure, but when an attempt is made to apply this to the simpler phenomena it is found inadequate, not only as a complete theory, but even as a supplementary one.

CHARLES G. BARKLA.

Liverpool, April 27.

### Echelon Spectroscopes and the Green Mercury Line.

It is interesting, in reference to Prof. Nagaoka's letter in Nature of April 23 (p. 581), to note that I exhibited photographs of the green mercury line, showing a nu nber of new components, at the Leicester meeting of the British Association. I did not publish the number or position of the lines in the report, not being quite satisfied that some of the fainter ones might not be produced in the instrument, and I discovered later (Nature, vol. lxxvii., pp. 198 and 222) that secondary effects, due to light reflected in the echelon, have to be taken into account. Since then Von Baeyer's measurements with a Lummer and Gehrcke spectroscope and Galitzin's echelon measurements have confirmed two of the lines that were new, and added confirmation to my values for the old ones. A doubt still remains, however, about some of the fainter lines, and as a comparison of the values given by different instruments is the most obvious way of confirming the true components and eliminating false ones, I give my results for comparison below.

It is usual in stating results of this kind to give the wave-length intervals between the components and the principal line, but this leads to mistakes in comparing results, because the principal line given by most of the observers has been divided by Von Baeyer and Nagaoka into two components, and by taking the brighter component as the principal line they shift the reference point about 15 milli-Ångström units, and the agreement, which would otherwise be evident, is quite obscured. I have given below the distances of the various components from the component of shortest wave-length, which happens to be a good reference line. The differences shown in Prof. Nagaoka's comparison are in this way much reduced.

*Comparison of Recent Echelon Spectroscope Determinations of the Components of the Green Mercury Line,* λ 5461.

| Janicki | Galitzin | Nagaoka | Stansfield | |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 17 bright |
| | | | 23 | faint |
| | | 31 | | |
| | | | 41 | very faint |
| | | | 59 | ,, |
| | | 72 | 75 | ,, |
| | | | 93 | ,, |
| | | 105 | | |
| 133 | 137 | 137 | 135 | 12 bright |
| 166 | 168 | 163 | 165 | 12 ,, |
| | 189 | 189 | 188 | 8 medium |
| **232** | **236** | { 223<br>**247** } | **232** | { 52 bright<br>*principal line* |
| | | 280 | 277 | 5 faint |
| 320 | 321 | 315 | 319 | 16 bright |
| | | | 345 | 8 medium |
| 365 | 365 | 356 | 363 | 12 bright |
| | | 390 | 386 | 8 faint |
| | | | 409 | very faint |
| | | 448 | 448 | 14 faint |
| | | 477 | 473 | very faint |

The numbers give the distances of the components from the component of shortest wave-length in milli-Ångström units. In the fifth column the widths of the brighter lines, taken from the photographs, are given in the same units.

It will be seen that there is generally close agreement as to the position of the five bright companion lines. As to whether the principal line is single or a close double, it is interesting to note that several of my photographs showed it divided, the brighter component being on the longer wave-length side as Nagaoka and Von Baeyer give it, but owing to the secondary effects in the echelon I have not been able to make sure of the division.

Prof. Nagaoka's values agree fairly well with mine for all the faint lines on the list below the principal line, although he does not give the lines on my photographs at 345 and 409, but we do not agree about the positions of those which fill in the long gap between the first and second bright companion lines. The agreement is not sufficiently good to exclude the possibility of some of the faint lines having their origin in the echelons.

H. Stansfield.

The University, Manchester, April 25.

### Appearance of the Slug Testacella in a Flooded District.

Some time ago I wrote to you to say that the remarkable slug Testacella occasionally appeared in large numbers on the surface of the ground in my garden. This phenomenon only occurs when the district is heavily flooded. The abnormal weather of the last half of April has brought severe floods out in many parts of the Thames valley, and yesterday, through the kindness of a friend who now occupies the house and garden referred to, I was able to collect about a hundred of these animals. I shall be pleased, therefore, to send specimens alive or preserved to those correspondents who wrote to me on the subject when my previous letter appeared in Nature, whose addresses I have mislaid, unfortunately, while changing houses. I may add that it is only in this particular garden that I have seen these animals. What the conditions may be that cause the slugs to live there and not elsewhere, so far as I know, in the neighbourhood, I am quite unable to suggest. They live too far down even in wet weather to be found during ordinary gardening operations.

M. D. Hill.

Eton College, Bucks, May 3.

## *THE TOTAL SOLAR ECLIPSE OF JANUARY* 3, 1908.

SINCE the brief announcement made in this journal (vol. lxxvii., January 23, p. 273) in the first month of this year, relative to the success of the eclipse expedition organised by Mr. F. K. McClean, further information has become available.

The communications received give a complete account of the doings of the expedition from the time it left Auckland in the Union S.S. Company's *Taviuni*, which Mr. McClean had chartered specially for the expedition, to its return to that port. A detailed report, containing the scientific results of the expedition, will in due course be presented to a society, but a short sketch will no doubt be of interest to many readers of this journal who have been waiting for further information.

The members who finally formed Mr. McClean's party were as follows:—Joseph Brooks, F.R.A.S., retired surveyor in charge, Trigonometrical Survey, N.S.W.; W. E. Raymond, F.R.A.S., first assistant, Sydney Observatory; J. W. Short, astronomical photographer, Sydney Observatory, and magnetic observer; Rev. F. W. Walker, of Auckland; Henry Winkelmann, of Auckland.

The party left Auckland on the afternoon of December 12, 1907, arriving at Tahiti on December 20; Flint Island was reached on December 23, at 7 a.m. The expedition from the Lick Observatory was already located on the island, and Prof. Campbell came off to meet the ship.

The landing place is described as consisting of a small channel blasted through the reef and extremely dangerous. In spite of the rough surf, everything was safely landed. As it was raining hard all the time, the first piece of work was the erection of the tents and the temporary housing of all the instruments in them.

The camp was located amongst a number of cocoanut trees, some of which were at least 100 feet high, rendering the horizon invisible. Considerable lopping of branches was found necessary, not only to allow sufficient sky field for the efficient working of the large siderostat, but room for the tents themselves. The accompanying illustration (Fig. 1) will give the reader some idea of the tropical and dense nature of the vegetation on the island. The negative from which this illustration has been taken was made by Mr. Winkelmann.

December 24 was even wetter than the previous day, but in spite of that the remaining tents were erected, and the first layer of concrete for the large

22-inch siderostat was laid. On January 1 everything was complete and drills were commenced, and eventually the programme was arranged to be carried through, utilising the signals called by Prof. Campbell's timekeeper.

From the account given of the weather conditions, on the morning of the eclipse the party seems to have met with exactly the same peculiarities as those which were experienced by many of the observers at Palma in 1905. Fortunately, Mr. McClean was present at Palma on that occasion, so the experience was not new to him, and in his letter he writes, "It has been another Palma and four plates in my bag."

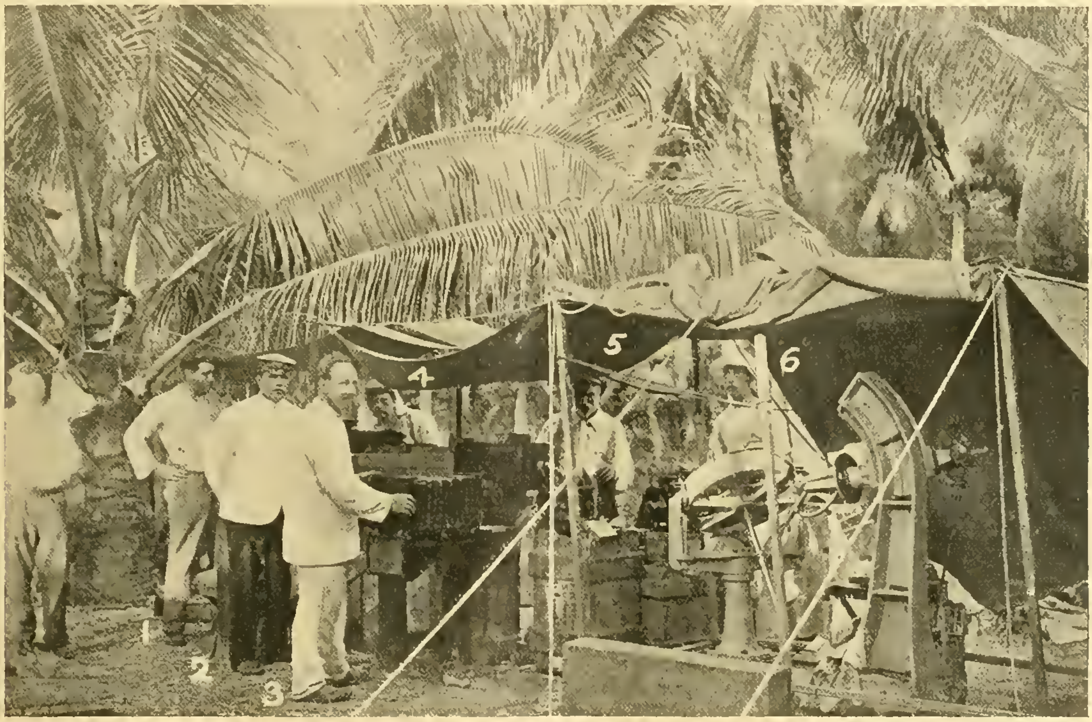
As the wind came in from between the north-east and east, special watch was kept in that quarter. First contact was observed in a perfectly clear sky, and it remained fairly clear to almost within a few minutes of totality. Everyone was prepared to carry out his allotted task when "five minutes before totality" was called out by the American timekeeper.

A heavy bank of cloud then made its appearance in the north-east, and at the signal "48 seconds to go before totality" it began suddenly to rain heavily, and it poured until one second before totality. It had been arranged to determine the instant of totality by observing the cusps, but the clouds prevented their observation. The timekeeper was to have received a signal from the "cusp" observer to commence his counting, but no such signal could be given. At what time the timekeeper started counting is not stated, but it is mentioned that just before totality, probably one or two seconds, because the thin crescent was seen to be just changing into beads, the cloud cleared, and the rain ceased.

The instruments were quickly uncovered, and the exposures made according to the prescribed programme. The clouds continued during the first minute with short intervals of clear sky, after which the eclipse was clearly visible, though light cloud was still present. At the call of 3 minutes 50 seconds, sunlight had broken out, several seconds before it was expected, and was preceded by a brilliant prominence.

Such a sudden and unexpected ending did not, however, spoil the plate which Mr. McClean was exposing at the time, for, as he writes, "then, while expecting another ten seconds, I looked up and saw a red prominence, and shut things up just in time. The others were not so lucky."

The eclipse does not seem to have been a dark one. It is stated that it never became too dark to read large figures, in spite of the instrument being surrounded by trees. Another statement is that a "newspaper could have been read without any difficulty whatever."




*Photograph by H. Winkelmann.*

FIG. 1.—Mr. McClean and party standing by the instruments they worked during the Eclipse. (1) Mr. McClean. (2) Mr. Caffyn. (3) Mr. Short. (4) Rev. Walker. (5) Mr. Brooks. (6) Mr. Winkelmann.

Captain G. H. Lacy, who observed the eclipse from the bridge of the *Taviuni*, compared the light during totality to that which would be produced from an arc lamp placed on deck.

Mercury and Venus were seen, the former to the south-west and the latter to the north-east of the sun. Very few stars were observed.

Mr. Raymond, who undertook sketching the corona, using a 4-inch Grubb refractor to project the sun's image on to a sheet of cardboard, likened the form of the corona to "an irregular star of seven points." The corona had a pearly-grey colour, and three of the streamers were shaped like pyramids. These were capable of being faintly traced down to the edge of the moon's limb.

Mr. Flynn, first officer of the *Taviuni*, also made a sketch of the corona.

With regard to the photographs, the following is a brief summary of the successful exposures secured:—

Messrs. McClean, Brooks and Walker, working with the 4⅝-inch De La Rue Coronograph, 8 feet focal length, obtained four pictures.

The same observers secured no results with the Voigtländer 4-inch objective, fitted with a Thorp replica grating.

Mr. Winkelmann, working with a telephoto lens of equivalent focal length of 5 feet 3 inches, obtained five pictures, showing various depths of corona.

Mr. Short (assisted by Mr. Caffin, purser of the *Taviuni*) worked a photoheliograph of about 7 feet focal length and a telephoto lens. Some of his results will also prove very useful.

It will thus be seen that while no spectroscopic results were secured, a very complete record of the form of the corona was obtained, and this was the chief object of the expedition.

With the exception of Raymond's refractor, all the objectives were fed from the 22-inch siderostat mirror taken out by Mr. McClean (see Fig. 1). The De La Rue and photoheliograph received the sunlight directly from the mirror, while the remainder were placed at right angles to the beam from the siderostat, and obtained their light by means of small mirrors placed in the path of the main beam.

Some of the original negatives, and glass positives of others, which have arrived from Auckland indicate at a glance what a magnificent sight the corona must have presented. No wonder the eclipse was not described as a dark one when such an extent of corona encircled the dark moon!

It has been stated, I do not know on what authority, that this eclipse resembled that of 1898. Mr. McClean's beautiful negatives do not in the least remind me of the form it took in that year. Mr. Raymond's description, as quoted above, "an irregular star of seven points," seems to define it very well, and that description could not be given to the form of the corona of 1898, which I observed in India.

In my opinion the photographs of the 1908 eclipse display a form which approaches more to that generally seen when the sun is most active, that is, a "maximum" corona, than to those of the "square" and "wind-vane" variety. Perhaps if it be classed as intermediate between a "maximum" and a "square" form, one cannot be far from wrong. In looking up the records of eclipses, I find that the drawing made by Mr. Weedon of the corona of 1860 July 18 (Memoirs, R.A.S., vol. xli., 1879, p. 543) more closely resembles that of 1908 than any I have been able to find. The year 1860 was a time of maximum sun-spot activity (and also probably a maximum of prominence activity, only no data are available to state this definitely).

Mr. McClean's photographs show several streamers more than one and a half lunar diameters in length. One striking feature of them is their great length and comparatively small breadth, giving them a very spiky appearance. Several prominences are also recorded on some of the negatives. Polar rifts are by no means clearly evident, and this is due possibly to the presence of some streamers in high latitudes.

As was to be expected, Prof. Campbell rendered considerable assistance to Mr. McClean's party, and Mr. McClean writes further in flattering terms of the cooperation of Mr. Mortimer, resident on the island, who rendered him "every assistance during the whole period we were on the island." He also expresses his deep obligations to Mr. A. B. J. Irvine, manager at Auckland of the Union S.S. Company, who did everything in his power to render the expedition a success.

Fortunately only one case of illness is reported. This was Mr. Raymond, who was confined to his bunk on board the *Taviuni* for four days owing to a severe attack of cholera. Although left very weak, he was able to rejoin the party ashore the day before the eclipse, and carry out his programme of sketching the corona as above mentioned.

In conclusion, it may be remarked that the results of the expedition are far more successful than one was led to believe from the previous information received, and the discussion of the photographs will form a valuable contribution to science.

William J. S. Lockyer.

## THE MUTATIONS OF ŒNOTHERA.[1]

THE name of an animal or plant may become famous for one of two reasons. Fame may be due either to the intrinsic interest of morphological or developmental characters of "intermediate," "primitive" or rare species, or to the fact that the form in question has been the material by means of which discoveries, which help in the revelation of the fundamental nature of living things, have been made. Examples of plants of the first class are Ginkgo, Ophioglossum, Coleochæte, and Anthoceros. Examples of animals of the first class are Peripatus, Archæopteryx, Acanthobdella, Ceratodus, Okapia, Sphenodon, Anaspides, and Tarsius. Thousands of specimens of an animal which is an example of the second class are daily hurled into the corner of the knacker's stable in the shape of *Ascaris megalocephala*. Thousands of specimens of a vegetable example of the second class could be gathered in a very short time on the sand-dunes along certain tracts of the coast of Lancashire in the shape of *Œnothera Lamarckiana*.

Yet these two classes of forms agree in one respect, that there is a certain magic about their names. Any contribution, however trivial, to a closer knowledge of such forms is regarded as worth publication. The importance of the material is held to compensate for the triviality of the contribution. We are not arguing that this should not be so, but merely pointing out that it is. A new fact, which, if it related to Periplaneta, would not be thought worth publishing will soon find its way into print if it relates to Peripatus.

Every biologist is familiar with, even if he does not take a critical interest in, the wonderful series of observations which have made *Œnothera Lamarckiana* a household word in the mouths of everyone interested in organic evolution. It is not surprising, therefore, to find this form subjected to an investigation which for minuteness and exhaustiveness is without parallel. Those who are familiar with the mutation theory might be excused for thinking that de Vries did not leave much to be done. But the memoir before us shows that, much as de Vries did, this is by no means the case; there is nothing in "Die Mutationstheorie" which for minuteness of detail compares with Dr. Shull's description of the fluctuations of Œnothera.

The memoir is illustrated by a series of beautiful heliotype plates of the various new elementary species to which Œnothera has given rise. Plate 5, which is here reproduced, shows at a glance the striking difference between two of these, *Œnothera lata* and *Œ. albida* forms with which everyone who knows de Vries's work must be familiar.

The part of this memoir which has interested us most is that which deals with the origin of mutants from strains of Œnotheras different from that which

[1] "Mutations, Variations, and Relationships of the Œnotheras." By D. T. Macdougal, A. M. Vail, and G. H. Shull. Pp. 92. (Washington: Carnegie Institution, 1907.)

de Vries found at Hilversum and observed his classical series of mutations in.

Three of these strains, from widely different sources, may be referred to.

In September, 1904, Mr. E. P. Bicknell, of Nantucket City, sent two sheets of dried material to the Botanic Garden at New York. The seeds of these specimens were sown in sterilised soil in November of the same year, and amongst the seedlings raised six corresponded exactly to the mutant *Œ. albida* raised by de Vries.

Amongst the seedlings raised from a packet of seed supplied by MM. Vilmorin et Cie., of Paris, there were one *Œ. lata*, one *nanella*, and one *albida*.

Lastly, some plants and seeds of a form provisionally called *Œnothera "biennis"* (Linnæus) were sent over from this country by Mr. H. Stuart Thompson, who had collected the actual seed he sent near Bidston Junction, not far from Liverpool. The plants raised from these seeds proved to be identical with the *Œnothera Lamarckiana* of de Vries, and the strain turned out, like that studied by de Vries, to be in a mutable state, for it gave rise to no less than four of the mutants which appeared at Amsterdam—namely, *Œ. lata, oblonga, albida*, and *rubrinervis*.

A. D. D.

A. Rosette of *Œnothera lata*, four months old, separate leaves of the same age. B. Rosette of *Œnothera albida*, four months old, and separate leaves of the same age.

## *THE INDIAN INSTITUTE OF SCIENCE.*

IN a recent article on the Jubilee of the Calcutta University it was shown that considerable efforts have been made in Bengal during the last few years to raise the level and tone of university education, and to render it more thorough and practical. Similar efforts are also being made in other parts of India by the Universities of Madras, Bombay, the Punjab and Allahabad, so that it may be hoped that a fairly high standard of university education will be maintained in future in India. Other indications also show that India is becoming alive to the necessity of modelling its educational system on the most modern European lines from the lower forms up to the very highest. The Indian Institute of Science, which is now being started at Bangalore, in Southern India, is an instance in point, and shows how the most advanced of the thinkers in India have grasped the necessity for the prosecution of the very highest forms of post-graduate work. Bangalore, which has been finally chosen for the site of the new institute, has (for India) a most excellent climate; it is situated about 3000 feet above sea-level, and the temperature there is never excessive, so that the conditions for work will be most favourable.

The institute owes its inception to the munificent generosity of the late Mr. J. N. Tata, a Parsee millionaire, who gave (during his lifetime) property which brings in an annual income of about Rs. 1,25,000 (8333*l.*) for the creation of an institute to be devoted to original research. Before the arrangements as to the endowment had been completed Mr. J. N. Tata died, but his two sons, Mr. D. J. Tata and Mr. R. J. Tata, have generously continued the arrangements made by their father.

Considerable discussion ensued as to the best method of utilising this endowment, and a committee was first formed in India to discuss it. Later Sir William Ramsay was asked by Mr. Tata to visit India and advise on the subject, and still later a committee consisting of Prof. Masson and Col. Clibborn made a report as to the best site for the institute and the best scheme of work. The final scheme, however, has been largely worked out by Dr. Morris W. Travers, F.R.S., who was appointed director of the institute about two years ago.

The actual starting of the institute has been much facilitated by two munificent gifts from H.H. the Maharajah of Mysore, who has made a grant of half a square mile of land at Bangalore (in Mysore) for the purpose of the institute, and has also given an annual endowment of half a lakh of rupees (3333*l.*). This has also been supplemented by an annual grant of Rs. 87,500 (about 5833*l.*) from the Government of India, so that the institute will have an annual income of at least Rs. 2,62,500 (nearly 18,000*l.*) for its work.

In addition, too, the Maharajah of Mysore has given five lakhs of rupees, and the Government of India two and a half lakhs, for the erection of buildings, and these sums, together with the accumulations of interest, will give about ten lakhs of rupees (66,666*l.*), and the buildings are to be proceeded with at once.

The constitution of the governing body has been decided on, and the greater part of the detailed initiative has been left to a local committee, consisting largely of the director of the institute and professors of the staff. Practically only post-graduate work and research will be carried on in the institute, and from its nature and position it will be able to attract the cream of the graduates and intellect of India. Provision is to be made for about sixty students to be at work. The subjects which will be taken up are those which are likely to have an important influence in the development of the various arts and industries of India. To begin the work of the institute, for the present five subjects have been decided on: pure and applied chemistry, organic chemistry, bacteriology and the study of fermentation processes, and electrical technology. Probably a sixth (metallurgy) will be added shortly.

India is thus bringing itself into line with the most advanced European countries in the matter of high education, and it may be hoped that every possible success will attend the new institute in its work.

## ANTARCTIC ICE.

THE following interesting account of Antarctic experience is from a letter by Prof. Edgeworth David, F.R.S., to Prof. W. J. Sollas, F.R.S. Prof. David is a member of Lieut. Shackleton's expedition:—

GREAT ICE BARRIER, EAST ANTARCTICA.
Lat. 78° 8′ S., Long. 173° 43′ W.
*British Antarctic Expedition*, 1907.
*January* 27, 1908.

S.Y. *Nimrod.*

We had some fearfully heavy gales after leaving New Zealand. Our little ship is only 200 tons, and if she had not been an excellent sea-boat and been splendidly handled she might not have survived it. At last we reached the belt of Polar Calms, and were at peace for a day or two: then sighted the heavy brigade of the Ice King, such a sight as I doubt whether any mortal man had seen before. We met, not pack-ice, but countless great tabular icebergs. It was like threading one's way through the streets of Venice with the Doge's Palace and blocks of buildings represented by the purest white alabaster inlaid with liquid sapphire and resting on a foundation of limpid emerald.

The bergs were mostly about 50 to 80 feet high, rarely over a hundred feet; many only about 30 or 40 feet high. Often we had to pass close between them, with a wall of ice on this side and a wall of ice on that. Frequently we seemed to be jammed into a *cul-de-sac*, but always there was some narrow channel into which our ship could be headed. We were about 20 hours steaming through them, the belt being altogether fully 100 miles wide, and probably of much greater dimensions from E. to W.

We knew after this experience that we should get no pack-ice at all between us and the Great Ice Barrier, towards which we were steering almost on the 180° meridian, and our anticipations were fully realised. We arrived at the Great Barrier on January 23. It is a sight that beggars all description. Imagine a continuous wall from Land's End to John o' Groats, 500 miles long and 100 to 200 feet high, the exquisite blue of the crevasses contrasting finely with the dazzling white of the weathered ice on either side of them. We followed it eastwards for about 80 miles, making for an intended base on the Great Barrier, Balloon Inlet. On arriving there the following day we found that Balloon Inlet, fully 10 miles long in 1901, had now completely disappeared, on a piece of ice over 12 miles in width, nothing but more or less high ice-cliffs.

Shackleton, our leader, then tried to force his way along the Great Barrier westwards, so as to get to King Edward VII. Land, but we were blocked by impenetrable pack-ice. Then we followed the pack north for about 100 miles, but it started slowly to envelop us, and we only just escaped in time. Shackleton was very disappointed at not being able to get to King Edward VII. Land, and now we are making for the only base available to us, that of the National Antarctic Expedition of 1901, MacMurdo Sound.

Shackleton is a very capable leader, and I believe that, bar serious accident, he will get to the Pole.

## INAUGURATION OF THE NEW CHANCELLOR OF CAMBRIDGE UNIVERSITY.

ACCORDING to custom the inauguration of the new Chancellor of the University of Cambridge took place in London. The Rev. E. S. Roberts, Master of Gonville and Caius College, the present vice-chancellor, accompanied by a certain number of members of the Senate, proceeded on Friday last, May 1, to 4 Carlton Gardens, where the Chancellor-elect received them in the house of his brother-in-law, Mr. Balfour. At noon the vice-chancellor took the chair, and the Senior Esquire Bedell escorted the Chancellor into the room. The train of the black and gold gown of office was carried by Lord David Cecil, the young son of Lord and Lady Salisbury.

In his address to the Chancellor, the vice-chancellor first dwelt upon the loss the University had sustained in the death of the late Duke of Devonshire. In referring to the new Chancellor, Mr. Roberts spoke as follows:—

It is of happy omen, my lord, that you yourself as a student attained to the highest possible academical honours in the oldest and most distinctive of our academical studies. This fact is not without significance for our University in the opening years of a new century. For you afford in your own person a conspicuous example, on the one hand, of reverence for a study which has in former generations made our University famous, and on the other hand of devotion to those newer outgrowths of that study in which Cambridge holds an eminent, if not a preeminent, rank. It is, therefore, with the more ready confidence that we look forward to the period of your Chancellorship as one in which the just balance between the old and the new may be stoutly maintained, and in which the studies of literature and social science may thrive and expand no less exuberantly than that of the natural sciences. One inestimable function of our University has been to quicken the intellectual life of the nation by lessons derived from the history and thought of the ancient world, and to hand on from generation to generation the humanising influence of literary culture. It would be a strange and cruel irony of fate that our generous and whole-hearted welcome of every development of modern science should in any way tend to alienate from us the sympathy and loyalty of those to whom the ancient studies have been dear. Yet it has at times appeared as if the danger of such alienation were no unreal one; as if the honest desire of Cambridge to meet national and Imperial needs were likely to entail consequences which would be deplored by the most ardent enthusiasts in modern science. In passing through such a crisis, if it is a real one, it is well and fortunate that we should have for our chief one whose public life and scientific reputation command the attention conceded only to an authority that is unquestionable.

Towards the end of his speech, the vice-chancellor announced that Lord Rayleigh had consented to occupy the chair of the Cambridge University Association which the Duke of Devonshire so ably and wisely filled.

The senior proctor then read the patent, which was handed by the vice-chancellor to the Chancellor, together with a copy of the statutes. The vice-chancellor read the "affirmation," to which the Chancellor replied "Ita do fidem." The vice-chancellor then handed the Chancellor to the chair, and the public orator read the following Latin speech:—

Dignissime Domine, Domine Cancellarie,—Kalendis Maiis, Floralium nostrorum festo et sollenni die, animo laeto agnoscimus, auspiciis quam bonis, "quo praebente domum," non iam Academi inter umbras sed urbis magnae in luce, Cancellarii novi in honorem purpura nostra vestiti, hic potissimum simus congregati. Tibi vero, vir honoratissime, quod Academiae officium summum a nobis libenter oblatum tam benigne accepisti, senatus totius nomine gratias propterea et agimus et habemus maximas. In honoribus quidem Academicis Duci Devoniae septimo, quondam Cancellario nostro, comparandus, inter nosmet ipsos illam ipsam scientiarum provinciam per quinquennium illustrasti, quae Henricum Cavendish, alumnum nostrum, inter conditores suos numerat, quae Willelmi Cavendish, Cancellarii nostri, munificentiae et officinam splendidam et experimentorum omnium supellectilem amplam iamdudum debuit. Cancellarium alterum, Cancellarii illius filium illustrem, virum de nobis praeclare meritum nuper amisimus, qui qualis in Academiam et in patriam universam quantusque vir fuerit, non est quod longius inter peritos exsequamur. Te vero, muneri illi insigni suffragiis nostris unanimis designate, virum salutamus et Regiae Maiestatis concilio privato et virorum optime meritorum ordini adscriptum, Regiae Societatis praesidem, scientiarum in republica principem, qui lucis sonitusque leges penitus indagasti, qui vis electricae modulos accuratissime determinasti, qui aëris ipsius partem inertem illam prius ignotam detexisti, qui scientiarum physicarum in provincia praemium orbi terrarum toti propositum haud ita pridem adeptus, pecuniae summam magnam non inertem reliquisti, sed Matris almae in manus totam collocasti, et Matris eiusdem filiis omnibus liberalitatis exemplar conspicuum praebuisti. Cancellarii autem ad officium hodie admissus, sine dubio iura et privilegia nostra omnia in tutelam tuam tradita, si quando opus fuerit, fortiter defendes. Tuo, ut speramus, sub patrocinio, non scientiarum modo studia florebunt, sed etiam, praemiis a Cancellario ipso iuventuti Academicae quotannis propositis, et iuris et litterarum Graecarum, Latinarum, Anglicarum, amor, sicut antea, accendetur. Dum gratias tibi hodie omnes ex animo agimus, nihil amplius restat quam ut tibi, vir honoratissime, Cancellarii in munere magno feliciter obeundo, annos prosperos quam plurimos exoptemus.

In his reply the Chancellor expressed his sense of the honour the Senate had done him in electing him to the high office, and mentioned his close connection with Cambridge, "the nursing home of Herschel, Airy, Stokes, Kelvin, and of Adams," both as student and as professor. Lord Rayleigh also recalled the fact that he had served, under the Act of 1877, on the Commission which framed the new statutes for the University and colleges; in fact, he and the Bishop of Bristol, who acted as secretary, are the sole survivors of that Commission. He spoke of the reforms which had been then effected, and referred to the view that they may still need supplementing, and he dwelt for a moment on the fact that the efficiency of the University would be promoted by the command of ample resources. The Chancellor paid a tribute to the late Duke of Devonshire, whose quiet and persistent interest in the University manifested itself in many ways. Indeed, his unremitting efforts to advance its welfare are probably only recognised by those who were brought into contact with him, both as head of the University and as president of the Cambridge Association.

In choosing Lord Rayleigh as its Chancellor, Cambridge has chosen one of the most distinguished men of science of the age, and one whom we feel sure will devote his energies to the promotion of the good of that ancient institution. In these days chancellors of universities have a good deal more to do than even the members of the Senate usually recognise. Apart from occasional appearances at ceremonies there is much and continuous work to be done; the interpretation of the statutes rests with the Chancellor, and in many ways he represents the University in the larger world. The new Chancellor of Oxford has shown what can be done even in a few months of wise activity in re-awakening interest in the older universities, and in defining and formulating a definite policy of expansion.

## PIERRE JACQUES ANTOINE BÉCHAMP.

BY the death of Béchamp, on April 15, at the ripe age of ninety-two, France lost the *doyen* of her chemists, and the world of science is the poorer by the disappearance of one more link connecting the new chemistry with the old. The nature of that link will be evident from the circumstance that Béchamp was born in the same year as Gerhardt, and that the period of his greatest scientific activity was contemporaneous with that of Laurent and Gerhardt.

Béchamp was born at Bassing, near Dieuze (Meurthe), on October 16, 1816. He lost his parents when he was eleven years of age, and was taken charge of by an uncle, who had settled in Roumania, and with whom he remained until 1834. In his seventeenth year he was apprenticed to a pharmacist at Strasburg. Pharmacy at that period constituted the main avenue to scientific chemistry, and in traversing it Béchamp simply followed in the footsteps of a dozen of his predecessors, some of whom, like Scheele, Vauquelin, Dumas, are among the most renowned of chemical investigators. At Strasburg, at that period, were Gerhardt and Wurtz, and, as in their case, Béchamp was soon attracted to the study of the rapidly extending branch of organic chemistry, and made ample use of the opportunities which his master's laboratory afforded to prosecute his inquiries. At that time, even in England, pharmacy was a profession, and the pharmacist was a practical chemist, abreast of the science of his time, whose laboratory was of more importance to him than his shop.

In 1851 Béchamp became attached to the School of Pharmacy at Strasburg, and thenceforth devoted himself to an academic career. Pasteur was then a professor of the Faculty of Science of Strasburg, and to him Béchamp presented a thesis on the newly discovered gun-cotton, which gained for him his doctorate of science in 1853. In 1856, at the age of forty, he became a doctor of medicine, and in the following year was appointed to the chair of medical chemistry in the Faculty of Medicine at Montpellier.

Béchamp was a prolific contributor to the literature of chemistry. The Royal Society's Catalogue of Scientific Papers enumerates upwards of 140 papers which proceeded from his pen down to the year 1873. As he continued his activity to the last, the total number cannot fall short of a couple of hundred. In addition he published a number of scientific treatises in book-form, mainly relating to chemical biology.

Béchamp's work ranged over nearly every department of chemistry. Inorganic chemistry appears, however, to have had little attraction for him, and his name is associated with not more than a dozen communications in that branch of inquiry.

It is mainly in connection with the early history of what is called coal-tar chemistry, and more especially in connection with the fields of investigation with which the name of Pasteur is preeminently associated, that Béchamp's services will be recalled. The method of manufacturing aniline ultimately made use of by Perkin in England, and by the brothers Renard in France, was due to Béchamp. It consisted in the action of ferrous acetate on nitrobenzene, and appears to have been first made known in 1854. He also contributed to the French Academy in 1860–61 communications on fuchsine and allied colouring matters.

But it was to the domain of biological chemistry that Béchamp's energies were principally directed, and he took an active part in the inquiries and controversies which ultimately led to the triumph of Pasteur and his immediate followers. Although much of Béchamp's work on fermentation, on the production of moulds, on the silk-worm disease, and on zymases ran parallel with Pasteur's inquiries, his interpretation of the phenomena was generally opposed to that of Pasteur, and the two investigators were frequently in acute controversy on these subjects. Béchamp's fame has probably suffered in consequence. We must, however, do him the justice to admit that his main contention, that unorganised ferments play a larger and more important part in the phenomena of metabolism than the immediate followers of Pasteur were willing to concede, is intrinsically sound. Béchamp developed his views into a general theory, which he published in 1866, whilst at Montpellier, in a work entitled "Microzymas et Microbes. Origine des ferments." This he supplemented some years later by a further work, "Les Microzymas dans leurs rapports avec l'hétérogénie, l'histogénie, la physiologie et la pathologie," Paris, 1883. Whatever may be the ultimate fate of his theoretical conceptions, his experimental work on blood, fibrin, milk, proteins, and his position in regard to the great and fruitful controversies of half a century ago out of which modern bacteriological doctrine has sprung, will ensure him an honourable place among the founders of biological chemistry.

On the creation of the Faculty of Medicine at Lille, Béchamp accepted the offer of a chair, and he remained there, as Dean, until his resignation in 1887, when he retired to Paris, and, accepting the hospitality of Friedel's laboratory in the rue Michelet, continued his biological inquiries, occupying himself to the end in searching for support for the comprehensive generalisation of organic change on which his fame will ultimately rest.

## *NOTES.*

THE Croonian lecture of the Royal Society will be delivered on Thursday next, May 14, by Prof. G. Retzius, upon the subject of "The Structure of the Central Nervous System of the Higher and Lower Animals."

THE President of the Board of Trade has appointed a committee to prepare a programme for the consideration of the delegates to the International Conference on Electrical Units and Standards to be held in London in the ensuing autumn, and to make arrangements for the reception and assembly of the delegates attending the conference. The members of the committee are Mr. G. R. Askwith, K.C., Sir John Gavey, C.B., Dr. R. T. Glazebrook, F.R.S., Major P. A. MacMahon, F.R.S., Major W. A. J. O'Meara, R.E., C.M.G., and Mr. A. P. Trotter. Mr. M. J. Collins, of the Board of Trade, will act as secretary to the committee.

M. BIGOURDAN read a paper at the meeting of the Paris Academy of Sciences on April 27 on the use of wireless telegraphy for weather forecasting. He pointed out that our weather is associated with the passage of atmospheric depressions arriving from the west, and generally from parts of the Atlantic situated north of 35° N. latitude, and it is estimated that about one-half of these depressions come from North America, whilst the others form in the open Atlantic. To forecast the arrival of depressions it is necessary to have observations from the open ocean. Floating observatories have been suggested, coupled with the continents on either side of the Atlantic. M. Bigourdan suggests that steamships should communicate, to the responsible authorities, their position and meteorological observations by wireless telegraphy, and by this means modify and improve our conditions for weather forecasting to the benefit of the general community. For some time past our English Meteorological Office has published in its Daily Weather Report wireless telegrams from ships of His Majesty's Navy.

THE sixteenth Congress of German Electrotechnical Engineers will be held at Erfurt on June 11–14.

THE Entomological Society will hold a conversazione on Friday, May 15, in the rooms of the Civil Service Commission, Burlington Gardens.

THE Rumford medal of the American Academy of Arts and Sciences has been awarded to Dr. E. G. Acheson, of Niagara Falls, for his work with the electric furnace.

THE Chemical Society of Rome, the Chemical Society of Milan, and the Association of Industrial Chemists of Turin will, from January 1, 1909, be united under the name of the Italian Chemical Society.

PROF. W. H. WALKER, professor of technical chemistry at the Massachusetts Institute of Technology, has been awarded the Nichols medal by the New York Section of the American Chemical Society.

MESSAGES from Catania report that dense clouds of vapour issued from the central crater of Mount Etna on April 29. The crater of 1852 in the Valle del Bove was also in eruption. On May 2 the volcano was again in active eruption, and a stream of lava was slowly advancing.

A CONVERSAZIONE will be given by the Medical Society of London on Monday, May 18, in the rooms of the society, Chandos Street, Cavendish Square. After the reception by the president, the Fothergillian medal will be presented to Sir Almroth Wright, F.R.S. An oration will be given by Mr. T. Clinton Dent on the subject of the after results of injuries.

ON Tuesday next, May 12, Prof. F. T. Trouton will begin a course of two lectures at the Royal Institution on (1) "Why Light is believed to be a Vibration"; (2) "What it is which Vibrates." The Friday evening discourse on May 15 will be delivered by Dr. H. T. Bulstrode on "The Past and Future of Tuberculosis," and on May 22 by Prof. J. C. Kapteyn on "Recent Researches in the Structure of the Universe."

AT the Institution of Electrical Engineers on April 30 Prof. Silvanus P. Thompson, F.R.S., gave the first Kelvin memorial lecture, his subject being "The Life and Work of Lord Kelvin." Before the lecture was delivered Mr. H. F. Parshall presented the institution with a bust of Benjamin Franklin on behalf of the American Institute of Electrical Engineers as a souvenir of their visit to England about a year and a half ago. The gift was acknowledged by Lieut.-Colonel R. E. Crompton, the president of the institution.

THE sixteenth International Congress of Americanists will be held under the presidency of Baron Weckbecker at the University of Vienna on September 9–14. The object of the congress is to promote scientific inquiries into the history of both Americas and of their inhabitants. Communications may be oral or written, and may be in one of several languages, English included. For further information application should be made to Herr Franz Heger, Vienna (Austria), I. Burgring 7. A programme will be issued early in the summer.

PROF. ANGELO MOSSO, of Turin, writes to remind us of the fact, to which attention was directed in an article by the late Sir Michael Foster in NATURE of March 9, 1905 (vol. lxxi., p. 445), that the Royal Society has the right to nominate two investigators to occupy tables in the Monte Rosa and Col D'Olen international laboratories. The tables are available for the study of botany, bacteriology, zoology, physiology, terrestrial physics, and meteorology. The two tables at the disposal of the Royal Society are, it will be remembered, due to the generosity of Dr. Ludwig Mond, F.R.S.

AT the annual general meeting of the Institution of Civil Engineers on April 28, Mr. J. C. Inglis was elected president of the institution. The council has made the following awards for papers read and discussed during the past session:—a Telford gold medal to Mr. W. Barclay Parsons (New York); a Watt gold medal to Sir Whately Eliot; George Stephenson gold medals to Sir John Ottley, K.C.I.E., Dr. A. W. Brightmore, and Messrs. J. S. Wilson and W. Gore; Telford premiums to Messrs. F. W. Davis (Darlington), C. R. S. Kirkpatrick (Newcastle-on-Tyne), Hugh T. Ker (Glasgow), G. H. Scott, R. R. Gales (India), and S. H. Ellis.

The exceptionally cold weather which had prevailed throughout April was temporarily interrupted with the opening days of May, and on the first and second of the present month some remarkably high temperatures were reported from different parts of England. At Greenwich the shade temperature on Saturday, May 2, registered 75°, which is a record reading for that day during the last half century. The thermometer on the previous day registered 73°. The report of the weather issued by the Meteorological Office for the week ending last Saturday states that at Jersey and Bettws-y-Coed the thermometer rose to 78° on May 2, and to 76° at places in the south-east of England and the Midland counties, and to 75° in the east and south-west of England. There was an abrupt change to cool weather again on Sunday, May 3, when in London the highest temperature was 52°.

The death is announced of M. C. E. Chamberland, the sub-director of the Pasteur Institute, Paris, at the early age of fifty-seven. M. Chamberland is probably best known in connection with the porcelain filter which bears his name together with that of his great master, Pasteur. He did much work on surgical asepsis, showing that the germs in the air may be disregarded provided the skin, the instruments, and the dressings be rendered sterile. He also contributed much to the prevention of animal diseases by the method of vaccination with attenuated viruses.

We regret to have to announce the death of M. Alfred Riche, one of the last of Dumas's pupils at the Sorbonne. Riche was born at La Roche-sur-Yannon on February 5, 1829. He was originally intended for the law, but becoming attached to science, after a course of study at the École Centrale, he accepted the position of *aide préparateur* under Dumas (1849). He subsequently became *préparateur* at the Institut Agronomique at Versailles, and then at the Sorbonne under Balard and Dumas. In 1874 he succeeded Bussy in the chair of mineral chemistry, which he occupied until 1899, and where he had as assistants Jaques and Pierre Curie, and as a pupil Moissan, who eventually succeeded and predeceased him. In 1862 Riche became an assayer at the Monnaie, and ultimately, in 1887, director of assays, a post which he continued to fill until last year, and he had charge of the revenue laboratories under the Minister of Commerce. He published a considerable number of papers on organic and mineral chemistry, chiefly on the organo-metallic derivatives of tin and arsenic, on copper-tin alloys, on the electrolytic estimations of metals, on sugar-analysis, &c. For many years he was the principal editor of the *Journal de Pharmacie et de Chimie*, and was the author of a number of text-books and manuals.

Mr. F. Howard Collins has sent us a copy of a paper by him, reprinted from the *Nautical Magazine*, in which he describes a method of representing by diagrams the characters of the lights of lighthouses, and of fog signals, so that they may be identified at a glance. He suggests that the system should be applied to Admiralty Charts and to the Admiralty List of Lights. A leading authority upon the subject has favoured us with the following remarks upon the proposed method and application:—"The writer proceeds on the assumption that each lighthouse completes its cycle in a minute. This is not the case, and this system of diagrams could not apply to lights the periods of which are (*a*) more than a minute; (*b*) not an integral fraction of a minute. That is to say that only lights with periods of 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, or 60 seconds can be represented. This would exclude the Nab, Hanois, Royal Sovereign, Dover Pier, South Foreland, Sunk, Galloper, Orfordness, Flamborough, and many other of our most important lights. Apart from this, it is considered that the diagrams are no improvement on the clearly composed description of each light as given at present in the light lists (such as Flash, 5 seconds, Eclipse, 10 seconds); indeed, it is very doubtful if they would convey any meaning at all to the less educated members of the seafaring community. This applies with additional emphasis to the diagrams representing fog signals. The extra expense of diagrams (and their periodical corrections) would be objectionable. The application of this system to the Admiralty Charts is altogether impracticable."

Sealing in 1907, according to a note by Mr. T. Southwell in the April *Zoologist*, was, owing to bad weather and the heavy ice-pack, nearly as bad as in 1905, which was the worst since 1898. Two of the fleet of twenty-four vessels were wrecked, and the number of skins secured by the others fell short of last year's total by close on 100,000, with a decrease of rather more than 30,000*l.* in money value. The total number of seals killed was just over 245,000, the market price being 4·20 dollars per cwt. for those of young animals and 3 dollars for those of adults.

According to *Museum News* for April, an exhibition of South American birds' nests has been installed in the children's museum, which has proved highly attractive alike to children and to adults. Excellent examples of protective resemblance are shown among the nests of certain flycatchers, in some of which the lichen-covered walls blend insensibly into the supporting branch or simulate a knot or other natural excrescence. Other exhibits are nests of the slate-headed tody swinging at the end of long, slender branches, and looking like bunches of drift-grass left in their present positions by receding waters. Nests of two species of spiny-tails (a group of woodhewers) are also shown, which by their dissimilarity in structure and material would not suggest relationship in their builders. The nests of five species of spiny-tails agree, however, in having a lining of grey lichens.

A collection of valuable and scarce books appertaining to botany and zoology, including a series of zoological works by J. Gould and D. G. Elliot, is offered for sale in the antiquarian catalogue recently issued by Mr. B. Quaritch.

A catalogue of new or noteworthy flowering plants from Mexico, Central America, and the West Indies, determined by Dr. J. M. Greenman, comprises a number of new species of Senecio and various composites, also additions to the Verbenaceæ, Euphorbiaceæ, and other orders. It is issued as Publication No. 126 of the Field Museum of Natural History.

The account of the desert basins of the river Colorado in the delta region where it flows into the Gulf of California provides a remarkable record. Attention was directed to the locality by the rise of water in the Salton Lake at the head of the delta from November, 1904, to March, 1907, since which time the waters have receded. The recession affords an opportunity for noting the spread of the vegetation, that is chiefly halophytic and partially xerophytic. With this purpose, surveys have been made by workers from the desert laboratory of the Carnegie Institution, beginning at the time when the flood was at its height. The preliminary account, by Dr. D. T. Macdougal, is published as a Bulletin of the American Geographic Society (December, 1907). Reference is made to a hot spring near Lake Maquata, where the water gave a temperature of 120° F. Two species of the algal genus Phormidium, and a new species of rain-water fish, *Lucania brownii*, were taken there.

The Geological Survey of Western Australia has issued an important report (Bulletin No. 29) upon the geology of the Cue and Day Dawn districts, Murchison goldfield, by Mr. H. P. Woodward. Owing to the voluminous character of the report, it has been issued in two parts, the first of which is confined to the Cue and Cuddingwarra centres, and the second to the Day Dawn centre. Much of the latter is occupied by an elaborate report upon the Great Fingall mine, the subject being dealt with, not only from the standpoint of the geologist, but also from that of the mining engineer. This mine, which produced 95·38 per cent. of the total production of 778,606 ounces from the district up to the end of 1906, is a low-grade property, which, owing to excellent management, is being worked at a profit. The reports are illustrated by five large geological maps, twenty-three mine plans, and nineteen admirable photographs. Particularly striking is the view, here reproduced, of the waste heap to which the sands from the cyanide process are delivered by belt-carriers. This heap, being more than 100 feet in height, forms a conspicuous landmark.


Tailings Dump of the Great Fingall Mine.

A vigorous article on the crisis in the French vineyard appeared in the *Times* (April 25), in which the author, Prof. L. Daniel, traces the sequence of events that have led to the present disastrous conditions. Primarily the fault is ascribed to the indiscriminate confidence placed in grafting as a panacea for combating phylloxera. The grafted vines also gave a large yield that suggested increased profits, so that growers were ready to overlook any possible disadvantages, such as deterioration in quality. As a result, there has been a large production of inferior wines, that are also unsuitable for storing. Prof. Daniel attributes the inferiority to the difference in root-growth, the American vine being a surface feeder, while the roots of the French vines penetrate deeper. It is noted how, in the course of time, grafted plants have deteriorated, and evidence has accumulated to show that phylloxera is amenable to treatment; in these circumstances growers are being officially advised to return to old methods, and aim principally at quality.

Three bulletins have reached us from the University of Wisconsin, all dealing with matters of considerable practical importance. One describes the conditions necessary for growing lucerne, a crop which is common enough in the United States as a rule, but is not as yet much grown in parts of Wisconsin. Since the development of the plant depends on the presence of the proper bacteria in the soil, farmers are recommended in doubtful cases to inoculate the land by scattering on each acre about two tons of soil from old lucerne land. If no such soil is available, the University Experiment Station is willing to supply hundred-pound lots so that a start may be made on a few rods of land, from which, of course, a considerable area can afterwards be inoculated. Another bulletin deals with the necessity for properly housing pigs, and the third urges the importance of systematically examining herds for tuberculosis, and slaughtering all animals that give the tuberculin reaction.

A report on the delimitation of the Turco-Egyptian boundary (June–September, 1906), by Messrs. E. B. H. Wade, B. F. E. Keeling, and J. T. Craig, which has just been published by the Survey Department of the Egyptian Ministry of Finance, furnishes an excellent example of the application of modern methods of surveying so as to yield a maximum of accuracy in result with a minimum expenditure of time. The survey operations consisted in running a traverse 210 kilometres in length, from a point on the beach at Taba, on the Gulf of Akaba, to Rafa, on the Mediterranean coast, fourteen points being determined on the route. The method employed was that of latitudes and azimuths, an assumed longitude being first taken for Taba, where the work began, and a final longitude obtained for Rafa, where it ended, by exchange of telegraphic signals with the Helwan Observatory, near Cairo. Notwithstanding the difficult nature of the country, both as regards topography and the troubles from dust-haze and mirage incident to work on a heated desert plateau, the traverse was completed in thirty-one days, including the computations and plotting of the boundary. The demarcation by permanent signals occupied fifteen days, and it is further interesting to note that the total cost of the survey operations amounted to £E460. The report includes detailed examples of the observations and reductions, and is valuable as a specimen of this class of work.

A convenient and handy form of refractometer, especially adapted for the rapid determination of the refractive indices of faceted gem-stones, but also applicable for liquids, has been designed by Dr. G. F. Herbert Smith, and two patterns of the instrument have been constructed and placed on the market by Mr. J. H. Steward. With the later (1907) pattern it is possible to determine a faceted stone in whatever form of mounting it may be set, and a scale visible in the field of the instrument enables the refractive index to be read directly to the second place of decimals. The range extends from 1·300 to 1·775, which includes the refractive indices of corundum (ruby and sapphire), the only gem-stones falling beyond this being almandine, demantoid, zircon, sphene, and diamond. The two patterns of instrument have been described in detail by Dr. Herbert Smith in the *Mineralogical Magazine* (1905 and 1907), and a more popular account is given by him in a pamphlet published by Mr. J. H. Steward ("The Herbert Smith Refractometer, and its Use, particularly for the Discrimination of Faceted Gem-stones," London, 1907, pp. 28). In this pamphlet a concise summary is given of the methods applicable for the discrimination of faceted gem-stones, it being pointed out that the determination of the refractive indices is often the only trustworthy test that can be applied when the stones are mounted. A carefully compiled table of the constants of thirty-four mineral species used in jewellery contains some new determinations, and will be found useful for reference.

The thirtieth yearly report of the Deutsche Seewarte, for the year 1907, shows that the work of that active and useful institution has been continued on the same lines as hitherto; the constant increase of its operations, as in the case of most other meteorological organisations, has made it necessary to add to its working staff. The number of observers in the mercantile marine was 962 at the close of the year; they are encouraged in their work by the award of medals and diplomas for excellent observations, as well as by a liberal presentation of official publications. The most important event of the year in the department of weather prediction was the acquisition of telegraphic reports from Iceland and the Færöe Islands, which have been found of great service; the early morning reports from the British Isles are also much appreciated. As in this country, special forecasts for agriculturists are issued during the summer season, but the dissemination of the information is on a much larger scale. Exploration of the upper air by means of kites and balloons is actively continued whenever practicable.

In the monthly meteorological charts of the North Atlantic and Indian Oceans for May, issued by authority of the Meteorological Committee, every available space is, as usual, occupied with data of importance to seamen. The face of the charts shows the average statistics relating to the atmosphere and the sea for the month in question, with latest intelligence on such subjects as ice, monsoons, &c. Among the interesting matters dealt with on the back of the charts we find a discussion of the observations of the Sargasso or Gulfweed from the records kept for the Meteorological Office during the seven years ended 1907, and the monthly frequency of fog in the Gulf of St. Lawrence for the period 1892–1906. There are also charts showing the cyclone tracks in the South Indian Ocean for 1848–1905, and a picture of the Southern Ocean ice during each of the months April to June, for twenty-three years ended 1907; some of these huge icy masses are said to have projected 1000 feet above the water-line, and to have been from two to forty miles in length.

Dr. Moschou, of Smyrna, has invented some improvements in the beams and bearings for physical balances. Balance beams have previously been designed which are roughly elliptical in cross-section or are of a channel section. According to the present invention, a section is adopted which is approximately elliptical, but has vertical sides, and if desired the elliptical tube may be strengthened by a rhombic frame. The bearings of the balance have also been considerably modified; for the usual knife edges, discs taking the form of two truncated cones placed base to base are substituted. For the centre bearing there are two such discs secured to the elliptical beam, and at the ends of the beam similar discs are supported by small axles. In some cases two discs are provided at each end of the beam, and the balance pans are supported upon these by hooks, hollowed at their bearing surfaces so that they always take up the same position upon the discs whenever they are removed and replaced. When two discs are thus used, the swinging of the balance pans backward and forward is largely prevented.

Part v. of the *Verhandlungen der deutschen physikalischen Gesellschaft* for the present year contains the results of Dr. P. Nordmeyer's further work on the mean specific heats of pure substances between the two temperatures −188° C. and 18° C. The method is identical with that used previously, and depends on the determination of the weight of liquid air evaporated by a body at ordinary temperature placed in it. The following are the values obtained:—sodium, 0·253; magnesium, 0·222; calcium, 0·157; iron, 0·097; molybdenum, 0·063; thallium, 0·038; gold, 0·033; aluminium, 0·182; yellow phosphorus, 0·178; potassium, 0·170; bromide of potassium, 0·103.

An eighth edition of Mr. Andrew Jamieson's "Elementary Manual of Applied Mechanics" has been published by Messrs. Charles Griffin and Co., Ltd. The book has been revised, some additions have been made to the text, and further examination papers included.

Messrs. Smith, Elder and Co. have almost ready for publication a work on "Animal Life," by Dr. F. W. Gamble. The volume comprises a series of studies in the life-history of typical members of the animal kingdom, describing their vital activities in relation to their structure, and the general scheme of development.

The current issue of the *Central*, the organ of the Central Technical College Old Students' Association, contains a portrait of Dr. G. T. Moody, and articles on the electrification of railways, by Mr. Lionel Calisch, and on the City of Victoria and Hill district waterworks, Hong Kong, by Mr. D. Jaffé.

A third edition of Dr. Alex. Findlay's translation of Ostwald's "Principles of Inorganic Chemistry" has been published by Messrs. Macmillan and Co., Ltd. The fundamental character of the book remains unaltered, and the changes in detail are not great, but here and there slight mistakes have been corrected and some additions made.

The report of the council and proceedings of the Hampstead Scientific Society for the year 1907 has been received. The membership of the society now stands at 286, and its finances are in a satisfactory state. As usual, the lectures given at the general meetings during the winter have been appreciated widely. Among the list of lecturers we notice the names of Prof. E. H. Starling, F.R.S., and of Dr. C. W. Andrews, F.R.S. The activity of the various sections of the society has been well maintained.

Mr. John Cooke, editor of Murray's "Guide to Ireland," is preparing an account of the tumuli and other pagan antiquities of the Boyne Valley for the "Handbook" of the British Association. It is to be hoped that at last their astronomical orientation will be given. Mr. Nathaniel Colgan, author of the "Flora of Co. Dublin," and one of the editors of "Cybele Hibernica," will deal with the local botany. The geology of the immediate neighbourhood of Dublin is specially interesting, ranging as it does from the Cambrian Bray Head to the Carboniferous limestone of the great central plain.

## OUR ASTRONOMICAL COLUMN.

DANIEL'S COMET, 1907*d*.—Signor Pio Emanuelli, of Rome, has favoured us with a manuscript copy of a daily ephemeris for Daniel's comet, calculated by him from the elements computed by Prof. E. Millosevich. An abstract from this ephemeris is given below:—

*Ephemeris 12h. (M.T. Paris).*

| 1908 | α (1908·0) h. m. | δ (1908·0) | r | Δ |
|---|---|---|---|---|
| May 8 | 14 7·6 | 0 51·1 | 0·590 | 0·467 |
| 16 | 14 1·4 | −0 31·0 | 0·000 | 0·487 |
| 24 | 13 56·2 | −0 18·8 | 0·010 | 0·508 |
| 31 | 13 52·6 | −0 14·5 | | |

From this it will be seen that the comet is now apparently travelling very slowly through the constellation Virgo in an easterly direction; its present magnitude is about 11·0, and it crosses the meridian about 11 p.m.

THE SOLAR ROTATION DETERMINED FROM HYDROGEN PHENOMENA.—From a discussion of the results obtained in a spectrographic determination of the solar rotation, using the hydrogen lines Hα, Hγ, and Hδ, Prof. W. S. Adams arrives at conclusions fundamentally important in any study of the solar structure; the full discussion, together with a description of the instrument and methods employed, appears in No. 3, vol. xxvii., of the *Astrophysical Journal* (April, pp. 213 *et seq.*).

The first conclusion is that the sun's rotational velocity as shown by the hydrogen lines is higher than that given by those of other elements and by the study of sun-spots and faculæ; the excess amounts to 1° in the angular motion at the equator. It is worthy of remark that Hα, which shows abnormal tendencies in its width, its intensity, and its behaviour at the sun's limb, gives slightly higher velocities than the other hydrogen lines. The second conclusion is that in the regions where the hydrogen lines are produced the equatorial acceleration of the solar atmosphere is non-existent, or too small to be measured by the present method. These conclusions point to the absorbing hydrogen being situated at a higher level than other absorbing media, *e.g.* calcium; a previous investigation (see NATURE, No. 1990, p. 158, December 19, 1907) showed that carbon and lanthanum gave lower velocities than general, and are, therefore, probably situated at a lower level.

The results of a study of the solar rotation, based on the measurements of hydrogen flocculi, are published by Prof. Hale in the same journal, and they confirm the absence of the equatorial acceleration in the absorbing hydrogen atmosphere of the sun.

THE CANALS AND OASES OF MARS.—In the *Century Magazine* for May (vol. lxxvi., No. 1, p. 127), Prof. Lowell continues his explanation and discussion of Martian features, taking the canals and oases as the special subjects of this article.

Recounting the history of the canaliform marking since their discovery by Schiaparelli in 1877, Prof. Lowell strongly emphasises the numerous points which go to prove their actual reality. The narrowest canal appears as it would were it but three miles across, but the average width is some twenty miles. They vary in length from 250 to 2500 miles, and one, the Eumenides Orcus, extends for some 3450 miles. Schiaparelli mapped 113, but 436 canals are now known to the Flagstaff observers. Of the oases, first seen by Prof. W. H. Pickering in 1892, there are now 186 marked on the Flagstaff map of Mars. The special features of all these markings, their seasonal variations, their similarities and concordant behaviour, and the weight of evidence added by the geminated canals, are all discussed by Prof. Lowell, and the results are shown to be consistent with the theory that the features are there for a set purpose, their functions having been determined by sentient beings for the sustenance of life and vegetation on a planet which has reached a stage further in the evolutionary process than has the earth.

THE COLOUR SENSIBILITY OF SELENIUM CELLS.—In a recent determination of the moon's light, Messrs. Joel Stebbins and J. C. Brown, of the Illinois University Observatory, found that the results depended upon the cell used, and suggested that the variation was due to differences between the colour-sensibility curves of the several cells (see NATURE, January 16 and 30, pp. 258 and 302). In a recent investigation Mr. Stebbins found that this explanation is correct, and in No. 3, vol. xxvii., of the *Astrophysical Journal* (April, p. 183) he gives the numerical results and a series of colour curves illustrating the variations of the four cells employed.

THE ASTRONOMICAL SOCIETY OF ANTWERP.—The third annual report (1907) shows that this society is progressive, and is fulfilling its primary purpose, the popularisation of astronomical science, exceedingly well. The instrumental equipment has been largely added to, the various meetings for practical work and for lectures are well attended, and there are now about 140 names on the list of members. An important event in the history of the society during the past year was the foundation of the *Gazette astronomique*, a most useful monthly journal for amateur observers.

## MICROGRAPHIC STUDY OF LEATHER.

UNDER the title "Étude micrographique du Cuir," M. Henri Boulanger has published in the *Bulletin de la Société d'Encouragement* for February of this year a series of interesting drawings showing the microscopic appearance of various sections of raw and tanned hide. The chief interest in these consists in the demonstration of the changes which take place in the skin during the process of tanning. About thirty years ago a very similar study was undertaken by the late Franz Kathreiner, of Worms, on the microscopic preparations of raw and tanned calf skin, in all the various stages of the tanning process, and the writer has had the privilege of seeing these very beautiful preparations; unfortunately, Kathreiner's results were never published.

The microscopic appearance of sections of raw skin is well known to those who have made a scientific study of tanning, but that of leather has not received so much attention owing to the difficulty of preparing sufficiently thin sections to be of use, and further of differentiating the constituent parts.

The author himself remarks that it is almost impossible to make a satisfactory section of the flesh side, and he has therefore confined his studies exclusively to the "grain" side of the skin. This is commonly called the epidermis, but it is difficult to apply strictly the vocabulary of the histologist; in this case the true epidermis disappears completely in the process of preparing the skins for tanning, and what the tanner calls the "grain" of the skins is the hyaline membrane covering the upper surface of the Rete Malpighi.

M. Boulanger's method of preparing the sections of raw skin has the advantage of being a rapid one; small pieces of skin are soaked for twelve hours in a solution composed of:—distilled water, 5 grams; glycerin, 5 grams; acetone, 90 grams. They are then allowed to dry, embedded in hard paraffin, and are ready for the microtome. The staining and mounting of the sections is carried out by the usual methods. The microscopic appearance of the sections was reproduced by coloured drawings made with the camera lucida, since a photograph will not show the various depths of the section. The illustrations shown are photographs of these drawings. Fig. 1 shows the appearance of a section of the grain side of a fresh cow-hide taken from the breast between the fore legs; in scientific language, the upper surface of the dermis—the fibro-elastic layer. It is stained with carmine alum, and shows clearly the flat, inert cells of the epidermis, which it is often difficult to preserve intact in microscopic sections, especially in a hide or skin which has been salted. Immediately below this are the living cells of the Malpighian layer; the nuclei of these cells are well shown in the figure. Just below this layer, which will eventually form the "grain" of the tanned leather, are seen the papillæ of the dermis; the dark spots are the nuclei of the cells of the connective tissue. A hair follicle is also shown, as well as a hair in vertical section. The magnification of the plate in the memoir is 285 diameters, and is one-half this amount in the accompanying reproductions of two figures. Compare the appearance of Fig. 1 with that of Fig. 2, which shows a section of cow-hide tanned with oak bark and curried with *dégras*.

Before describing Fig. 2, it is necessary to explain the mode of preparation of the section. A small strip of leather about 10 mm. wide is taken, and the flesh side shaved away until the piece has a thickness of about

FIG. 1.

2 mm. The shaved strip is placed in melted tallow, not too hot, for about a quarter of an hour; after cooling, the strip is embedded in hard paraffin and cut in a Ranvier microtome, the sections degreased with xylol, then washed two or three times with alcohol, and stained with Weigert's fuchsin; the staining takes about three hours; the

FIG. 2.

Weigert solution is poured off, and a few drops of absolute alcohol put on to the section; this removes excess of dye, and differentiates the various parts. It is now washed twice with alcohol, passed two or three times through xylol to eliminate the alcohol, and finally mounted in balsam.

In M. Boulanger's view, the skin, when freed from the hair and the histological epidermis (both of which are got rid of in the preparatory processes), is composed of two tissues, an upper and a lower, intimately united, although of distinctly different natures. No scientific designation has been given to these two distinct layers, but the whole has been called the dermis; in view of their special constitution, and to distinguish them, he calls the "grain" the fibro-elastic layer and the "flesh" the layer of giant connective fibres. The elastic fibres in their natural state take up Weigert's stain readily, and they retain this property after tanning; both before and after the tannage they form the essential framework of the skin or leather; without them there is no elasticity or suppleness, and tanning does not appear to alter their constitution. The connective fibres, on the contrary, are completely changed, so that we may conclude that the tannin acts differently on the two tissues.

The present writer will not here discuss this conclusion, though in his opinion there is no such distinct difference between the two portions of the skin, but that in the "grain" the connective tissue is fine and closely compacted, whereas in the "flesh" it becomes loose and coarse; thus the difference is in degree, and not in constitution. Boulanger's fibro-elastic layer must not be confounded with the elastic yellow fibres which form a comparatively small part of the volume of the skin. Comparing the two figures, there is a striking contrast in the general setting of the elastic fibres. In the raw skin they ramify in all directions, whereas in the tanned skin they only exist in a longitudinal direction, as a consequence of the dilation and preparation that the skin has undergone.

M. Boulanger has utilised his method in the study of leather for use as belts, &c., the results of which are published in his book, "Essais du Cuir dans ses Applications industrielles." There is no doubt that the method of microscopic examination of leather might be of considerable use after much practice in the manipulation and comparison of various leathers has been acquired. It would then be possible to determine whether the leather under examination had been made from a salted skin or a fresh skin, of European origin, or from a foreign dried skin, the sex of the animal, cow, ox, or bull; whether the leather had been adulterated, overloaded with tannin or weighting materials, &c., in short, the history of the pelt might be deduced from the study of the tanned leather. Let us hope that the younger generation of tanning students now being trained in the leather industries department at the University of Leeds and at Herold's Institute in Bermondsey will keep up the reputation of England in this work.

J. T. W.

## THE ATOMIC WEIGHT OF RADIUM.[1]

ALTHOUGH there has been a considerable amount of discussion, based upon spectroscopic considerations and on its supposed mode of genesis, respecting the place of radium in the system of the elements, and inferentially, therefore, concerning its atomic weight, we are indebted for the only direct experimental determinations of this value hitherto made known to the discoverer of the element, Mme. Curie. Her first observations, published in 1902, were made on about 90 milligrams of the chloride, and furnished the value 225.

In the autumn of last year Mme. Curie communicated to the French Academy the results of a second series of estimations made upon about 4 decigrams of the carefully purified chloride; these afforded the value 226·2 as the mean of three closely concordant determinations ($Ag = 107·8$, $Cl = 35·4$).

In 1906, at the instance of Sir William Huggins, then president of the Royal Society, and by the aid of the kind interest shown by H.R.H. the Prince of Wales, the Austrian Government placed about 500 kilograms of pitchblende residues from Joachimsthal at the disposal of the Royal Society. These residues were worked up by M.

[1] Bakerian Lecture for 1907. Delivered at the Royal Society by Dr. T. E. Thorpe, C.B., F.R.S.

Armet de Lisle at Nogent-sur-Marne. The funds were defrayed from a grant made by the Goldsmiths' Company to the Royal Society, in 1904, for the purpose of the investigation of radium.

The process of extraction produced about 413 grams of anhydrous barium chloride, containing radium chloride sufficient to give the salt a radio-activity 560 times that of uranium.

This salt was received by the Royal Society in the autumn of 1906, and was handed to me in January, 1907, with the request that I would extract the radium chloride from it, and undertake, if possible, a re-determination of the atomic weight of the element.

The method of extraction was substantially that adopted by Mme. Curie, namely, systematic fractional crystallisation, first from water and then from increasingly strong hydrochloric acid, until finally the acid used was the strongest that could be obtained by distillation.

Whilst still engaged in the isolation of the radium chloride from the material furnished by M. Armet de Lisle, I received a further small supply of radium from the Royal Society. It was bought in Cambridge, and purported to be radium bromide, but on removing it from the capsule, in which it had been stored since 1903, it was found to be wholly insoluble in water. On treatment with pure dilute hydrobromic acid it readily passed into solution. The salt obtained by evaporation was sent to Prof. Rutherford, who had kindly undertaken to make any measurements of radio-activity which I needed. He estimated the amount of radium present as equivalent to 33 milligrams of radium bromide. This salt was eventually converted into chloride, and was purified by repeated crystallisation from strong hydrochloric acid.

*Determination of Atomic Weight.*—This was effected by ascertaining the amount of silver chloride yielded by a weighed quantity of the anhydrous radium chloride—the principle of the method already employed by Mme. Curie.

A method was devised whereby the whole of the operations of drying and weighing the radium chloride, precipitating, washing, drying, and weighing the silver chloride, might be performed in one and the same vessel, thus obviating the necessity of transferring the silver salt and of separating it by any of the ordinary processes of filtration.

The vessel in which these operations were made consisted of a thin glass tube with a conical base furnished with a hollow, well-ground stopper. It had a capacity of about 15 c.c., and was as light as was consistent with the requisite strength, and could be suspended from the balance-arm by fine platinum wire. In all the weighings a precisely similar bottle of almost identical weight and capacity, suspended in like manner, was employed as a tare. The weighings were made on a very sensitive assay balance, with 4-inch arms, carrying a maximum load of 12 grams, and provided with light stirrup pans.

The washed silver chloride was first dried at 100°, and then heated in the air bath to 160° for about a couple of hours, and, after standing in the desiccator over phosphoric oxide for about eighteen hours, was weighed in the manner described.

In order to test the practicability of the method and to acquire experience of its working, as well as to gain some idea of its accuracy before actually making use of it in the case of the radium salt, a series of determinations of atomic weight of barium was made with purified barium chloride.

The results were as follows:—

$Ag = 107\cdot93$. $Cl = 35\cdot45$.

| Barium chloride, milligrams | Silver chloride, milligrams | Atomic weight, Ba |
|---|---|---|
| 114·7 ... ... | 157·8 ... ... | 137·5 |
| 172·1 ... ... | 236·8 ... ... | 137·5 |
| 57·1 ... ... | 78·8 ... ... | 136·9 |
| 62·6 .. ... | 86·1 ... ... | 137·6 |
| 68·1 ... ... | 93·7 ... ... | 137·5 |

The value for barium adopted by the International Committee on Atomic Weights, 1907-8, is 137·4.

It will be seen from these numbers that a close approximation to the true atomic weight of barium can be obtained by the method described, the maximum error being about half a unit, or less than 0·5 per cent. Considering that the atomic weight of radium is probably nearly double that of barium, the same fortuitous errors would affect its value to about a unit.

As the work of isolating and purifying the radium chloride proceeded, determinations of the amount of chlorine were made as described from time to time, and as soon as approximately constant values were obtained it was assumed that any barium or other impurity present was too small in amount to affect the results when regard was had to the unavoidable experimental errors. The resulting chloride was then repeatedly and carefully recrystallised from pure, strong hydrochloric acid, the "tails," which were comparatively rich in radium, being specially set apart.

The purified salt finally extracted from the material supplied by M. Armet de Lisle weighed, when anhydrous, 64 milligrams.

I regard this salt as substantially radium chloride. I am not, however, in a position to say that it was absolutely free from barium. At the same time, I have reason to believe that the amount still present was probably too small materially to influence the result, considering the limited quantity of the salt I had to work with, and the consequent relatively large experimental errors.

With the aid of Sir William Huggins, who kindly made the spectroscopic trials for me, I was able to carry out Mme. Curie's test of comparing the relative intensity of the lines of barium and radium in the spark spectrum of the separated radium chloride. Mme. Curie compared the relative strengths of lines 4554·2 of Ba and 4533·3 of Rd. Although these have the advantage of being close together, they are of dissimilar intensity. Sir William Huggins advised that a more stringent test would be to take the line 5536·2 of Ba of intensity 10, and compare it with the Rd lines 5813·8 and 5560·8, which are also of intensity 10. On actually making the trials, which were repeated several times, the green Ba line 5536·2, although visible, was seen to be relatively very feeble—less intense, indeed, than that afforded by the most dilute solution of barium chloride we were able to employ.

With this material, therefore, I attempted to make the determination of atomic weight. Accordingly, the greater portion was transferred to the vessel already described, and the amount of chlorine in the anhydrous salt determined with all possible care. The result was:—

| Radium chloride, milligrams | Silver chloride, milligrams | Atomic weight, Rd |
|---|---|---|
| 62·7 ... ... | 60·4 ... ... | 226·8 |

The radium was recovered from the solution, re-converted into chloride, added to what remained of the original quantity, and the amount of chlorine again determined in the anhydrous salt. The second result was:—

| Radium chloride, milligrams | Silver chloride, milligrams | Atomic weight, Rd |
|---|---|---|
| 63·9 ... .. | 61·8 ... ... | 225·7 |

The purified chloride obtained from the Cambridge material amounted to 24 milligrams.

It was added to the main bulk, and the whole was repeatedly crystallised from strong hydrochloric acid, about 6 milligrams being thus removed in the mother liquors. After being dried at 150° it was again analysed, with the following results:—

| Radium chloride, milligrams | Silver chloride, milligrams | Atomic weight, Rd |
|---|---|---|
| 78·4 ... ... | 75·3 ... ... | 227·7 |

The mean value is 226·7, or, to the nearest unit, 227. This, it will be observed, is in very close accord with Mme. Curie's latest number.

I think, therefore, it is reasonably well established that the atomic weight of radium is now known to within a unit which, considering the relatively high number, is, in the present circumstances, as fair a degree of exactitude as could be anticipated.

## KINEMATOGRAPHY IN NATURAL COLOURS.

AT the inauguration, on May 1, of Urbanora House, where the Charles Urban Trading Co. make kinematograph films, Mr. G. Albert Smith gave a demonstration of the first examples that he has prepared of his system of animated photography in natural colours. The results were excellent, the colours being bright and clean, and so far as one could judge from the drapery, flowers, and flesh tints, they were very good copies of the originals. The method which Mr. Smith has practically perfected allows of the use of the ordinary bioscope and projection apparatus and the ordinary film. The film itself is not coloured at all, but consists, as in other methods, of colour records, the colour being supplied by stained films behind it.

The three-colour method of projection, of which Mr. Ives was the chief pioneer from a practical point of view, has been described in this Journal, and consists, shortly, in photographing the redness, greenness, and blueness of the subject, and then, by means of colour screens placed behind these photographs and three projection lanterns, combining the coloured images on the screen. Kinematography with three lanterns would offer great, if not insuperable, difficulties, besides requiring new and very complicated apparatus. Mr. Smith therefore makes his colour records alternately on the same strip of film by fixing a disc that carries the necessary colour screens in front of the film and causing it to rotate synchronously with it. As seen on the sheet, the alternating colours combine perfectly. To simplify the matter further, Mr. Smith has done away with the blue screen altogether, and broadened the spectrum bands transmitted by the red and green screens, the latter including some blue. As the blue in three-colour work is always a dark colour, its elimination, together with the readjustment of the other two colours, is justified in the result, whether it is theoretically correct or not. The method thus simplified left the difficulty of the comparative insensitiveness to red of ordinary films. The method of rendering the film so sensitive to red that the red image may be photographed at the necessary speed Mr. Smith does not describe, but apparently he used a bathing process.

Thus it has been demonstrated that it is now possible to represent colour and movement at the same time in a thoroughly practical manner, and with comparatively simple apparatus.

C. J.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The date of the installation of the Chancellor in the Senate House is fixed for Wednesday, June 17.

Graces will be offered on Thursday, May 14, recommending the establishment of the proposed new professorship of biology, and gratefully accepting the proposal of a member of the University to contribute the sum of 300*l.* per annum for five years towards the stipend of the professor, this offer to be increased to 400*l.* per annum for any portion of the five years during which the professor may be holding a professorial fellowship.

It is proposed to continue the Caley lectureship now held by Dr. Baker and the Stokes lectureship now held by Dr. Hobson in mathematics; each lecturer is to receive a stipend of 200*l.* a year, payable by the University so far as the benefactions received for these purposes are insufficient. It is also intended to continue the appointment of the lecturers in mechanical engineering and in electrical engineering, which would lapse at Midsummer unless the University otherwise determine, and it is proposed in future to appoint three demonstrators of mechanism and applied mechanics in place of the two who now exist.

The special board of studies recommends the appointment of a university lecturer in agricultural physiology for five years from Midsummer, at an annual stipend of 150*l.*, payable out of the agricultural education fund.

The election to the professorship of political economy will take place on Saturday, May 30. Candidates are requested to communicate with the Vice-Chancellor on or before Monday, May 18.

The professor of botany records the gift of more than 4000 specimens of British plants, in excellent order, and mounted and prepared with unusual care. These have been presented by the Rev. J. D. Gray, Clare College, Vicar of Nayland, Suffolk.

The syndicate appointed to consider the steps to be taken for the erection of a building for the department of agriculture recommends that it be authorised to accept a tender for the building described in a report to the Senate, provided the cost does not exceed the architect's estimate of 13,000*l.* If this proposal should be accepted by the Senate and the building be proceeded with, it will almost exhaust the funds collected by the Cambridge Association for the agricultural school, and leave nothing for furniture and fittings or for maintenance. It is hoped that the funds of the agricultural building, in which the late Duke of Devonshire took so keen an interest, and which he did so much to collect, will be increased materially before the end of the year.

LONDON.—A course of eight lectures on the "Structure and Functions of the Central Nervous System" will be given in the physiological department of University College by Dr. W. Page May on Wednesdays at 5 p.m., beginning on Wednesday, May 13. The lectures are open to all students of the University and to qualified medical men on presentation of their cards.

PROF. H. POINCARÉ, professor of astronomy in the Paris École polytechnique, has resigned his chair, and has been given the title of honorary professor.

THE new Education (Scotland) Bill introduced in the House of Commons on March 26, and read a second time on Tuesday, May 5, is not so comprehensive a measure as the Bill of last session. It is interesting, however, to notice how much larger a part educational matters pure and simple take in the Scottish Bill compared with Education Bills affecting England. The Bill for Scotland now before Parliament proposes to give school boards additional general powers for the supply of meals subject to provisos with regard to defraying expenses, for bringing opportunities for education within easier reach of children in outlying districts, and for collecting and distributing information as to employments open to children on leaving school. It makes it the duty of the parent to provide efficient education for his children from five to fourteen years of age, and gives the school board power to summon to one of its meetings parents neglecting their duty, and if satisfactory reasons are not forthcoming to issue an attendance order, which, however, may be made the subject of appeal to the Sheriff. The school board is given power also, in issuing exemption certificates, to impose as a condition of exemption such attendance as it shall prescribe, after the age of fourteen and until such age not exceeding seventeen years as the school board shall think fit, either at a day school or continuation class, or both. The school board must provide continuation classes, and may make, vary, or revoke bye-laws regulating attendance at continuation classes. It is made a punishable offence to employ a boy or girl at any time when his attendance is by any bye-law required at a continuation class, and parents must assist the school board under liability to fine. The Bill is thus a first step to make education in Scotland compulsory up to the age of seventeen, through continuation schools.

A DISCUSSION took place in the House of Commons on April 29 on the subject of education in India, and a motion was brought forward for "an impartial and searching inquiry into the scope, character, and methods of education in India." The grounds on which this proposal was urged were that the Indian Government had pronounced in favour of free elementary education, but no progress had been made towards it. Also that only one-tenth of the boys of school-going age were actually at school, while the proportion of girls at school was very much smaller even than this. It was also pointed out that the "amount of money spent on education was deplorably inadequate, being only about $1\frac{1}{2}d.$ per head of the children of school age." It was also urged that the education given had been a "great deal too literary," and that the "whole training had not been sufficiently scientific and practical." The proposal was supported by two or three members and opposed by others who are well acquainted with India and with educational problems, and it was pointed out that "it was a bad thing too frequently to pull up a plant by its roots to see how it was growing." Mr. Hobhouse, who replied on behalf of the Under-Secretary of State for India, had no difficulty in showing that the request for a committee of inquiry was unnecessary. He assured the House that educational questions had within the past few years been thoroughly investigated and discussed in India by various conferences, commissions, and committees, that the educational system had been recently thoroughly overhauled and re-modelled, and that it is now on more practical and thorough lines than formerly, and that special attention had been paid to primary, secondary, and technical education. Also that the expenditure on education had been almost doubled within the last ten years, and that every effort would be made to increase this expenditure, due consideration being given to other pressing wants in the country. He assured the House that the Secretary of State for India was in fullest sympathy with the object which those proposing the motion had in view, but he was unable to accede to the request, "because the work of education in India had progressed and was steadily being pushed forward, and any inquiry of the sort suggested would not really expedite it." The motion was then withdrawn.

WHEN the British Association met in Bristol ten years ago, Sir Norman Lockyer referred at the closing meeting to the fine educational establishments of the city, and expressed the hope that at some future meeting the association would find Bristol at the head of some great south-western university. Since that time the movement for a University of Bristol has made substantial progress, and frequent references have been made to it in these columns. An important meeting was held at Bristol on April 25 under the auspices of the Bristol and District Workers' Educational Association, when an earnest appeal on behalf of the scheme for a university for Bristol was made by the Bishop of Hereford, the president of the University College. Dr. Percival said he was not sure that the people of Bristol at large had really grasped the extent of the advantages which would accrue to the city in connection with the establishment of a university for Bristol and the west of England. Bristol claims to be the "lantern of the west," and if she is to maintain that claim in future and to maintain her position in the forefront with all the other great cities of England, all grades of citizens must unite in the endeavour to crown their system of educational institutions by the establishment of a university. As local patriots he appealed to them to give their sympathy and their efforts in support of the movement. He put this question to himself, "Why should not I, as a citizen of Bristol, be able to claim as much as if I belonged to Liverpool, Manchester, Sheffield, Leeds, or Birmingham?" Every one of those great cities has secured its university. But the question may naturally be asked, "What are we to gain by a university?" He said he could answer that question in almost a single word. We need only look at a country like Scotland to see what is gained by the possession of popular universities. The population of Scotland is only about $4\frac{1}{2}$ millions, and Scotland has its four ancient universities. If any part of the kingdom or the Empire has profited more by education than all the rest it is Scotland, and Scotland owes its preeminence to the fact of its having enjoyed and made use of those four universities. If we turn from Scotland, Wales is close behind, and has profited immensely by her university colleges and national university. Then in Ireland we are beginning to multiply the universities, and should the citizens of Bristol be content to stand aside? He assured them from a long experience that nothing they could do in Bristol would be better for the education and the future well-being of the working classes of the city than that they should use their best efforts to secure a university.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Chemical Society**, April 2.—Sir William Ramsay, K.C.B., F.R.S., president, in the chair.—Rate of hydrolysis of chloroacetates, bromoacetates, and $\alpha$-chlorohydrin by water and by alkali, and the influence of neutral salts on the reaction velocities (preliminary note): G. **Senter**. The results of an investigation of the rate of displacement of halogen by hydroxyl for bromoacetic acid, its sodium salt, and for $\alpha$-chlorohydrin, and the effect of certain neutral sodium salts on the reaction velocities are given. These confirm the view that the effect of neutral salts is mainly due to their action on the reacting substances, and appear to be incompatible with the hypothesis advocated by Armstrong and his co-workers, that neutral salt action is due to combination between salt and solvent, with consequent concentration of the solution.—The constituents of Cyprus origanum oil. Isolation of a new terpene, "origanum": S. S. **Pickles**. The oil consists mainly of carvacrol. There are also present (1) a hydrocarbon, $C_{10}H_{16}$, apparently a new terpene, for which the name *origanene* is proposed (2·5 per cent.); (2) cymene, which, together with associated terpenes, constitutes 8·5 per cent.; (3) terpene alcohols (3·5 per cent.); and (4) high boiling residue (1·3 per cent.), besides very small quantities of a second phenol, and probably *iso*butyric acid. Origanene is probably $\Delta^{1:3}$-p-*menthadiene*.—The displacement of halogen in *l*-phenylchloroacetic acid by hydroxy- and methoxy-groups. A contribution to the chemistry of the Walden inversion: A. **McKenzie** and G. W. **Clough**.—The condensation of epichlorohydrin with phenols: D. R. **Boyd** and E. R. **Marle**. The condensation product of phenol and epichlorohydrin is glyceryl diphenyl ether, and not phenyl glycide ether, as Cohn and Plohn suggested. Similarly, the crystalline compound obtained from *p*-cresol and epichlorohydrin is glyceryl di-*p*-tolyl ether.—A new general method of preparing diazonium bromides: F. D. **Chattaway**. Primary aromatic hydrazines react quantitatively with the diazonium perbromides, producing diazonium bromides.—The absorption spectrum of triphenylmethane: A. G. G. **Leonard**. The cause of the difference between the absorption curve plotted by Hartley in 1887 and that plotted by Baker in 1907 is shown to be due to the presence of an impurity in the sample originally examined.—The nature of the impurity found in preparations of triphenylmethane: W. N. **Hartley**. The impurity referred to in the preceding paper appears to be triphenylmethyl.—The constitution of coordinated compounds: S. H. C. **Briggs**. The existence of the two compounds $(Pt6NH_3)Cl_4$ and $(PtCl_6)K_2$, in which the platinum atom is the basis of a complex cation and anion respectively, suggests the view that the platinum atom has both positive and negative affinities, and formulæ giving expression to this view are suggested and discussed.—A combined stop-cock and capillary connecting tube for gas burettes: A. E. **Hill**. The apparatus is figured and described in the original.—The hydrolysis of amygdalin by emulsin, part i.: S. J. M. **Auld**. It has been shown that Jorissen and Hairs's "emulsin" is really a mixture of two enzymes, viz. true emulsin and a maltase-like ferment, and the effect of varying the concentration of amygdalin and emulsin has been investigated, as also the action of many inhibitants.—Complex nitrites containing potassium and lead (preliminary note): A. N. **Meldrum**.—The composition and formula of Wells's potassium lead periodide: A. N. **Meldrum**.—The molecular complexity of amides in various solvents: A. N. **Meldrum** and W. E. S. **Turner**. Determinations of the molecular complexity of eleven amides in various solvents confirm the Nernst-Thomson theory that the smaller the dielectric constant of the solvent the greater is the association of the solute.—The optical activity of compounds having simple molecular structure: W. J. **Pope** and J. **Read**. Chlorosulphoacetic acid and chlorobromomethanesulphonic acid each contain an asymmetric carbon atom in the molecule, but, although their strychnine and quinidine salts crystallise well, no evidence was obtained that the acids are resolvable into enantiomorphously related components.—Acetylketen: a polymeride of keten: F. **Chick** and N. T. M. **Wilsmore**.—Saponification of ethyl formate by water in presence of acids as catalytic agents: A. **Lap-**

worth.—The triazo-group, part iii., bistriazo-derivatives of ethane and of acetic ester: M. O. **Forster**, H. E. **Fierz**, and W. P. **Joshua**.

Physical Society, April 10.—Dr. C. Chree, F.R.S., president, in the chair.—An experimental investigation of the nature of $\gamma$ rays: Prof. W. H. **Bragg** and Mr. **Madsen**. The view that the $\gamma$ rays are not ether pulses, but are material and consist of neutral pairs of one negative with one positive electron, developed in previous papers (*Phil. Mag.*, October, 1907), is held to be established by the experiments described in this paper with the secondary radiation produced by the $\gamma$ rays of radium.—Experiments on artificial fulgurites: Miss D. D. **Butcher**. The first part of the paper deals with natural fulgurites, and the second with the production of artificial fulgurites. The experiments show:—(1) The tubes are formed by fusion of the powder which surrounds the column of air in which the spark passes. The length and thickness of the tube depend on the energy of the spark, and also on the character of the spark, *i.e.* whether it is unidirectional or oscillatory. (2) There is no appreciable difference in the two ends of a tube provided that the two electrodes are alike. When one electrode is a point and the other a flat plate, any branching that may occur will be towards the plate, whichever electrode is made positive. In nature, the flat plate would be represented by the moist lower strata of the soil. Therefore we cannot say from the character of the tube whether the lightning discharge was from a positive or negative cloud. (3) The difference between thick and thin tubes is due probably to a difference in the sharpness of the flash and the resulting explosive effect. When the explosive effect is great and the quantity of material melted is small, the result will be a large-bored, thin-walled tube. Whether this remains circular or becomes pressed together and distorted depends merely on whether the fused matter has time to cool before the outward pressure of the blowing has been overcome by the inward pressure on the surrounding sand or not. In nature, the damp sand or soil probably acts as the damp string in these experiments, and consequently causes many lightning discharges to be unidirectional. In the experimental tubes the outward pressure was so great, and the quantity of fused material so small, that the walls were broken through and left as a mere network.—Short-spark phenomena: W. **Duddell**. The paper deals with two effects which the author has observed in connection with some measurements of the current in the secondary circuit of an induction-coil. The apparatus in use consisted of a 12-inch Newton induction-coil, which was supplied from the 200-volt direct-current mains. A large resistance was placed in series with the primary of the coil to limit the current, and the current was interrupted by means of a mercury-jet interrupter. The secondary circuit contained a galvanometer to measure the mean current, and a thermo-ammeter to measure the root mean squared current. When there was no spark-gap in the secondary circuit and the coil was in action, the mean current, as read by the galvanometer, was zero, and the root mean squared current about 3·8 milliamperes. If, now, a microscopic spark-gap, say between two aluminium points, was introduced into the secondary circuit, two curious effects took place. Firstly, the R.M.S. current enormously increased in value, and, secondly, a very large deflection was produced on the galvanometer in the direction corresponding to that due to making the primary circuit. The introduction of a spark-gap 1/10 mm. long caused the R.M.S. current to rise to 38·5 milliamperes, and this continued to increase with increasing length of spark-gap until it reached a maximum with a gap about 1·4 mm. The author thinks that this effect is due to very high frequency oscillations set up in the wires connected to the secondary circuit of the coil when a spark-gap is introduced. He has observed the effect with brass, iron, zinc, and aluminium electrodes, but the latter metal is the best to use.

Mathematical Society, April 30.—Prof. W. Burnside, president, in the chair.—A general convergence theorem and the theory of the representation of a function by a series of normal functions: Dr. E. W. **Hobson**. A general convergence theorem is established, which, when applied to series of Sturm-Liouville functions, suffices to show that the question whether the series converges, or not, at a particular point, depends only upon the nature of the function in an arbitrarily small neighbourhood of the point, whilst the nature of the function throughout the whole interval of representation is restricted only by the condition that it must possess a Lebesgue integral in the interval. The theorem is further employed to show that, subject to the same condition as regards the nature of the function, the question whether the series converges uniformly, or not, in an interval in which the function is continuous, depends only upon the nature of the function in an interval which encloses the interval of continuity in its interior, exceeding it in length by an arbitrarily small amount.—The ordering of the terms of polars and transvectants: L. **Isserlis**. Between any two non-adjacent terms $T_1$, $T_2$ of a polar or a transvectant a series of terms $T_{1,1}$, $T_{1,2}$, . . . $T_{1,i}$ can be placed so that any term in the series $T_1$, $T_{1,1}$, . . . $T_{1,i}$, $T_2$ shall be adjacent to the terms on either side of it. In the paper a method is developed for actually ordering all the terms in this way.—Oscillating successions of continuous functions: Dr. W. H. **Young**. The paper deals with the theory of series which neither converge nor diverge to a definite limit. In such cases the sum function is replaced by two functions, the upper and lower functions of a sequence. The theory of uniform convergence and divergence is extended to series of functions which oscillate at every point.—The relation between the convergence of series and integrals: T. J. I'A. **Bromwich**. It is proved that when $\phi(x)$ tends steadily to infinity, as $x$ increases, but more slowly than $x$, the behaviour of the integrals

$$\int^{\infty} f(x)\sin\phi(x)dx,\quad \int^{\infty} f(x)\cos\phi(x)dx,$$

determines the character of the series

$$\sum^{\infty} f(n)\sin\phi(n),\quad \sum^{\infty} f(n)\cos\phi(n).$$

—The multiplication of series: G. H. **Hardy**.—Porisms: H. **Bateman**.—The influence of viscosity on wave motion: W. J. **Harrison**.—Informal communications were made as follows:—(1) Mersenne's numbers; (2) Quartans with numerous quartan factors: Lieut.-Colonel A. **Cunningham**. In the first a factor 150287 was reported of the number $2^{163}-1$. This result reduces to 18 the number of Mersenne's numbers (of the form $2^q-1$) which have not yet been verified, and none of these 18 numbers contains any factor less than 200,000. In the second it was shown how to construct numbers of the form $x^4+y^4$ which shall have any desired number of divisors of the same form.

PARIS.

Academy of Sciences, April 27.—M. H. Becquerel in the chair.—A problem relating to the theory of left-handed curves: Gaston **Darboux**.—The application of wireless telegraphy to the improvement of meteorological warnings: G. **Bigourdan** (see p. 14).—The zoological relations of the shrimps of the order of Stenopidæ: E. L. **Bouvier**.—Entropy: M. **Auric**. An expression for entropy derived from the density of the ether, assuming its pressure to represent the absolute temperature.—The ionisation of air by ultra-violet light: Eugène **Bloch**. On repeating the original experiments of Lenard, it was found that the greater part of the Lenard effect could be traced to the presence of particles in the gas. When the gas is completely freed from dust, the Lenard effect, if it exists, represents only a small fraction of the effect due to the dust.—The velocity of transport of the ions H, Cl, and OH in the electrolysis of solutions of hydrochloric acid: E. **Doumer**. From the experiments described the author concludes that the ionisation of water takes an active part in the electrolysis of solutions of hydrochloric acid, and the velocity of transport of the Cl and H ions is sensibly the same.—The detection of helium in minerals containing uranium: F. **Bordas**. The method described in a previous paper (selective absorption with charcoal at low temperatures) has been applied to numerous minerals containing uranium. Its delicacy is sufficient to detect helium in 1 milligram to 2 milligrams of brœggerite, liebigite, or æschynite. Minerals containing definite crystallised uranium compounds, such as torbernite, autunite, and Californian carnotite, give no helium. A list of minerals containing uranium in which helium has been detected is given.—The direct use of copals in the manufacture of varnish without a preliminary heating: Ach. **Livache.** The necessity for preliminary heating of the copal, with its accompanying loss, can be avoided by using amyl alcohol containing some tenths per cent. of acid as the solvent.—The levers in the organism: Aug. **Michel.**

CALCUTTA.

**Asiatic Society of Bengal**, April 1.—Skull of a gigantic ray of the genus Ceratoptera: Captain R. E. **Lloyd.** The specimen was cast ashore at Puri, on the Orissa coast, and forms the type of a new species. The genus does not appear to have been recorded hitherto from Indian seas.—Fresh-water sponges from the Bombay Presidency and Burma: Dr. N. **Annandale.** The two collections were made in November, 1907, in the Western Ghats, and in March, 1908, at Rangoon and the Amherst district of Tenasserim. The Bombay collection includes several species originally described by Carter from that Presidency, as well as others new to science, not hitherto known from India, or only recorded from Bengal.

## DIARY OF SOCIETIES.

*THURSDAY*, MAY 7.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4 30.—Helium and Radioactivity in Rare and Common Minerals: Hon. R. J. Strutt, F.R.S.—The Action of Resin and Allied Bodies on a Photographic Plate in the Dark: Dr. W. J. Russell, F.R.S.—Seleno-aluminium Bridges: Prof. G. M. Minchin, F.R.S.—A Tantalum Wave-detector, and its Application in Wireless Telegraphy and Telephony: L. H. Walter.

ROYAL INSTITUTION, at 3.—Mendelian Heredity: William Bateson, F.R.S.

CHEMICAL SOCIETY, at 8.30.—The Interaction of Diazonium Salts with Mono- and Di-hydric Phenols and with Naphthols: K. J. P. Orton and R. W. Everatt.—The Condensation of Benzoin with Methyl Alcohol: J. C. Irvine and D. McNicoll.—The Mutual Solubility of α-Methylpiperidin and Water: O. Flaschner and B. MacEwen.—The Melting Points of the Anilides, *p*-Toluidides, and α-Naphthylamides of the Normal Fatty Acids: P. W. Robertson.—The Refraction and Dispersion of Triazo-compounds: J. C. Philip.—The Dissociation Constants of Triazoacetic and α-Triazopropionic Acids: J. C. Philip.—The Absorption Spectrum of Camphor: W. N. Hartley.—The Viscosity of Solutions: C. E. Fawsitt.—The Action of Fused Potassium Hydroxide and of Hydrogen Peroxide on Cholesterol, Preliminary Note: R. H. Pickard and J. Yates.—The Fermentation of Mannose and Fructose by Yeast Juice, Preliminary Communication: A. Harden and W. J. Young.—The Volumetric Estimation of Silver: W. R. Lang and J. O. Woodhouse.—The Constituents of Olive Leaves: F. B. Power and F. Tutin.—The Constituents of Olive Bark: F. B. Power and F. Tutin.

LINNEAN SOCIETY, at 8.—Colony-formation as a Factor in Organic Evolution: H. M. Bernard.—Antipatharia from the Voyage of H.M.S. *Sealark*: C. Forster-Cooper.—A List of the Fresh-water Fishes, Batrachians, and Reptiles obtained by Mr. J. Stanley Gardiner's Expedition to the Indian Ocean: G. A. Boulenger, F.R.S.—A Cinematographic Representation of the Movements of Peripatus and other Invertebrate Animals: F. Martin Duncan.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY, at 8.—Abbreviated Formulæ for Structural Engineers: E. Fiander Etchells.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Manufacture of Electrical Condensers: G. F. Mansbridge.

*FRIDAY*, MAY 8.

ROYAL INSTITUTION, at 9.—Ice and Its Natural History: J. Y. Buchanan, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Theory of the Motion of the Moon; containing a New Calculation of the Expressions for the Coordinates of the Moon in Terms of the Time: Prof. E. W. Brown.—The Proper Motion of Small Stars: S. W. Burnham.—Second Index Catalogue of Nebulæ and Clusters of Stars found in the Years 1895 to 1907: J. L. E. Dreyer.—Results of Micrometer Observations of Double Stars made with the 28-inch Refractor in the Year 1907: Royal Observatory, Greenwich.—*Probable Papers*: An Empirical Law of Astronomical Refraction: Prof. H. H. Turner.—On the Practical Testing of Concave Parabolic Mirrors: Rev. C. D. P. Davies.

PHYSICAL SOCIETY, at 8.—A Modified Theory of Gravitation: Dr. C. V. Burton.—An Examination of the Formulæ for the Grading of Cables: C. S. Whitehead.—Illustrations of Geometrical Optics: R. M. Archer.

*SATURDAY*, MAY 9.

ROYAL INSTITUTION, at 3.—Chile and the Chilians: G. F. Scott Elliot.

*MONDAY*, MAY 11.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Geographical Conditions and Railway Construction in the Balkan Peninsula: Noel Buxton.

*TUESDAY*, MAY 12.

ROYAL INSTITUTION, at 3.—Why Light is believed to be a Vibration: Prof. F. T. Trouton, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.

FARADAY SOCIETY, at 8.—The Industrial Uses of Ozone in Connection with Water Purification: F. Mollwo Perkin.—Determination of Boiling Points of very small Quantities of Liquids: L. O'Dowd and F. Mollwo Perkin.—An Apparatus for Measuring Dielectric Constants of Non-conducting Liquids: Dr. Veley, F.R.S.

*WEDNESDAY*, MAY 13.

ROYAL SOCIETY OF ARTS, at 8.—The Underground Water Supplies of the Thames Basis: Clayton Beadle.

*THURSDAY*, MAY 14.

ROYAL SOCIETY, at 4.30.—Croonian Lecture: The Structure of the Central Nervous System of the Higher and Lower Animals: Prof. Gustaf Retzius, For.Mem.R.S.

ROYAL INSTITUTION, at 3.—Mendelian Heredity: W. Bateson, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—On the Invariants of the General Linear Homographic Transformation in Two Variables: Major P. A. MacMahon.—On the Order of the Group of Isomorphisms of an Abelian Group: H. Hilton.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Switch Gear Control Apparatus and Relays for Alternating-current Circuits: Dr. C. C. Garrard.

IRON AND STEEL INSTITUTE, at 10.30 a.m.—On Improvements in Plate Rolling Mills: A. Lamberton.—On the Physical Qualities of Steel in Relation to its Mechanical Treatment: J. E. York.—On a New Fatigue Test for Iron and Steel: Dr. T. E. Stanton.—On an Experimental Electric Furnace for the Smelting of Iron: Prof. B. Igewsky.

*FRIDAY*, MAY 15.

ROYAL INSTITUTION, at 9.—The Past and Future of Tuberculosis: H. T. Bulstrode.

IRON AND STEEL INSTITUTE, at 10.30 a.m.—On Cast Iron in the Construction of Chemical Plant: F. J. R. Carulla.—On the Application of Colour Photography to Metallography: E. F. Law.—On the Utilisation of Blast-Furnace Slag for Portland Cement: C. von Schwarz.—On the Department of Metallurgical Chemistry in the National Physical Laboratory: W. Rosenhain.—On the Pyrometric Installation of the Ordnance Factories, Woolwich: J. Wesley Lambert.

ROYAL SOCIETY OF ARTS, at 8.—The Dangers of Coal Dust and their Prevention: W. E. Garforth.

## CONTENTS.

THURSDAY, MAY 14, 1908.

## A CONTRIBUTION TO THE HISTORY OF MEDICINE.

*The History of the Study of Medicine in the British Isles.* By Dr. Norman Moore. The Fitz-Patrick Lectures for 1905–6, delivered before the Royal College of Physicians of London. Pp. viii+202. (Oxford: Clarendon Press, 1908.) Price 10s. 6*d.* net.

THERE are two ways in which a scientific subject may be taught—the logical method, which describes the facts, and follows the course of reasoned demonstration; and the historical method, which follows the progress of knowledge by which facts are accumulated long before their logical sequence has been ascertained. The geometry of Euclid follows the former course, as do most of the exact sciences. The history of navigation follows the historical method, and so does the history of medicine.

Complete histories of medicine are few and far between, and, with the exception of the unfinished treatise of Dr. Freind, have not dealt with more than fragments of the subject. Medical biographies, like Dr. Payne's "Life of Sydenham," or the excellent biographical articles dealing with physicians in the "Dictionary of National Biography," begun by Leslie Stephen, and happily completed by Sidney Lee, furnish an example to all professions, but to write the history of a science demands a knowledge of the successive labours by which each in turn contributed his stone to the great edifice.

Dr. Caius, president of the College of Physicians of London in 1555, Sir Hans Sloane, president in 1719, beside Dr. Hamey in 1640, and Dr. Freind in 1725, had each of them attempted a history of medicine.

After mentioning the names of some, chiefly Royal physicians of our Norman kings, Dr. Moore gives a comparatively full account of John Mirfeld, the author of a treatise on medicine which he called the "Breviarium Bartholomei"; he lived in the Convent of St. Bartholomew, in Smithfield, a separate foundation from that of St. Bartholomew, though both were founded by Rahere.

Among other "cases," Mirfeld records that of hydrocephalus in a girl, who was tapped by a cautery on two occasions, and with final success.

Another patient of Mirfeld was a Canon, who was thrown from his horse and taken up without sense or motion; the patient's head was shaved, rubbed with oil of roses in warm vinegar, bound up with bandages, and covered over all with a lamb's skin. Strict abstinence from food was enforced until the fourth day, when for the first time he spoke, and was able to swallow; on the sixth day he was given some chicken broth, followed by laxative pills. Mirfeld afterwards recommended the patient to eat brains of kids and fowls, with the object of supplying the injuries of the patient's brain.

Beside the "Breviarium," which is based on the famous "Regimen Sanitatis Salerni," Mirfeld compiled a "Florarium Bartholomei," which was discovered among the MSS. of the British Museum. Mr. Gilson, the discoverer of this MS., lent it to Dr. Norman Moore, who has given us four columns of the text, which can be deciphered with comparative ease by the help of a magnifying glass. Yet another fragmentary MS. by Mirfeld was discovered in the library of Lambeth Palace, which is inscribed with the name of Archbishop Sancroft. Among the more modern medical works which Mirfeld mentions were translations of "Rhazes' Serapion" and of "Avicenna." He knew something of Horace, Ovid and Virgil, of Boethius, of the Vulgate, and of the commentaries of Augustin, Anselm, and Thomas Aquinas.

Dr. Moore, in his second lecture, deals with the education of London physicians in the century of Harvey and Sydenham. Thomas Linacre, the first president of the college, was a learned man who had studied Greek under Demetrius Chalcondylas, a refugee from the Turkish invasion. He will always be revered as the founder of the Royal College of Physicians. Like Mirfeld and the earlier physicians, he was a scholar first and a physician afterwards, and like Mirfeld he took holy orders. He wrote a Latin grammar, and belonged to that little group of learned men who adorned the golden time of Henry VIII.'s youth. Erasmus was a welcome addition to the English scholars, Sir Thomas More and Dean Colet, the founder of St. Paul's School. The young king was himself a scholar and a musician in that happy *Decennium Neronis.*

All these scholars were accomplished Grecians. Edward Wotton, who was president of the college in 1541, was a learned man, and also a natural historian. He describes three kinds of thrushes, the missel-thrush, *Turdus viscivorus,* the song-thrush, *Turdus musicus,* and the red-wing, *Turdus iliacus.*

Another learned physician, Caius, who took up the study of natural history, wrote a book on the breeds of dogs in England, and a most valuable monograph on the sweating sickness. He also founded at Cambridge the college called after his name, which has always been connected with the study of medicine. A greater genius than any except Harvey himself was Wm. Gilbert (1540–1603), the author of the first treatise on the magnet, published in 1600, the year in which he was elected president of the College of Physicians; it has lately been re-published in a fine edition by Prof. Silvanus Thompson in 1902.

Dr. Moore wisely passes the two greatest names in medicine with a bow, for the life and works of Harvey and Sydenham have been repeatedly and adequately dealt with. Dr. Payne's admirable volume on Sydenham, and several recent Harveian orations, render full justice to each. Another early fellow of the college was a French physician, Theodore de Mayerne (1573–1655), an accomplished chemist, to whom we owe "Lotio Nigra."

Glisson is chiefly known by his work on the "Anatomy of the Liver," but to him is due the first recognition of what he called irritability as a property of living tissues of which muscular contractility is only one manifestation. We must not forget the connection of the College of Physicians with what is now called "The Pharmacopœia," and thereby with the growing study of chemistry.

The eminence of Sir Thomas Brown was literary rather than scientific, but his "Religio Medici" confers undying lustre on perhaps the greatest prose writer of the seventeenth century. His son, Dr. Edward Brown, was educated at Trinity College, Cambridge, and in 1644 he petitioned for his degree, and was duly admitted by a Grace when Dr. Francis Glisson was regius professor of physiology.

On one of his visits to London, Edward Brown studied the anatomy of a hare and a skeleton of a monkey, and a few weeks later dissected a hedgehog and a badger; on this occasion he saw in the King's zoological collection several outlandish (*i.e.*, foreign) deer, a sheep from Guinea, a white raven, and a stork which had broken his leg and used a wooden substitute with dexterity.

Edward Brown remained with his father at Norwich, studying anatomy, botany, and chemistry; in 1664 he left Norwich for London and Dover, and thence to Paris, where he lived in a room in the Rue Zacharie for seven francs a month; here he attended lectures on surgery, hernia and fevers, and studied in the "Hotel Dieu" and "La Charité," as so many English physicians have done since, and still do if they are wise. On leaving Paris he went to Montpellier, then famous as a school of medicine.

He next visited Rome, thence travelled to Venice and Padua; and returned to Montpellier and Paris where he caught small-pox. After his recovery he returned home, but in 1668 he visited Holland devoting himself to its libraries, museums, and universities: Thence he travelled to Vienna and Greece, and returned by Styria and Hungary to England; his last journey was to Cologne. He was president of the College of Physicians in 1704, and died in 1708.

Sydenham was comparatively uninfluenced by the progress of anatomy and science, and this, as Dr. Payne has shown, was probably due to his brothers and possibly himself having enlisted in the Commonwealth Army.

It is remarkable how very few "cases" of disease are described by Sydenham or his predecessors; the explanations of the symptoms, which were mostly mistaken, leave little room for observation of facts. We must admit that in the latter part of the seventeenth century, as in the first half of the nineteenth century, the most fruitful progress in clinical medicine was in Paris, not in London.

Dr. Moore was the first to direct attention to the accurate clinical account of the symptoms during life, and to read between the lines by the light of our present knowledge, that in all likelihood the death of Henry Prince of Wales, which changed the course of English, and perhaps of European, history, was due to enteric fever, as shown by the symptoms during life and by the examination after death.

The medical memoir on his father, James I., was accurate and interesting, but it is difficult to make out more than that he suffered from gout, while that on Ann of Denmark is illustrated by a letter from herself to Mayerne.

Thomas Willis, the author of "The Anatomy of the Brain," published in 1664, accomplished his great anatomical work at Oxford, where he filled the chair of natural philosophy.

Richard Morton published in 1689 his treatise on consumption under the title "Phthisiologia." It has the great merit of being no mere speculation, but *variis historiis illustratum*. He discusses causes of phthisis, which he regards as sometimes a nervous disease. Other cases he ascribes to hæmorrhage, others to excessive lactation or to dysentery.

Another section treats of wasting due to diabetes with polyuria. He gives the names and addresses of many of his patients, but uses the decent obscurity of a learned language. Other cases of diabetes he ascribes to salivation, others to dropsy.

The eighteenth century was, on the whole, inferior to the seventeenth in England. The leading physicians were Radcliffe, the founder of the museum which bears his name at Oxford; and Arbuthnot, the first of the many physicians who earned perpetual fame by their services to great men of letters. They were followed by Mead, who was also repaid by the gratitude of Pope; Freind, who began the "History of Medicine" too early to be of much value, but who gave occasion for extorting from Walpole the prescription which cured his gout, and also secured Freind's pardon. Sir Samuel Garth was more literary than medical. Mead and Freind were good writers, but did not attain to the level of Arbuthnot.

In the latter half of the eighteenth century, Heberden was the leading physician in London after he had lectured on medicine in Cambridge, where notes of his lectures were taken by Dr. Erasmus Darwin in 1752. He died in 1801, having lived nearly ninety years, and his admirable commentaries were only published after his death by his second son. This was the most original and valuable treatise an English physician had then made; as Dr. Moore remarks, the method of examining a patient in the time of Heberden scarcely differed from that of Galen in the reign of Marcus Aurelius, the chief exception being counting the pulse. Percussion and auscultation, the ophthalmoscope, the laryngoscope, and electrical reactions were all invented in the nineteenth century.

In the eighteenth century, Sir Hans Sloane, the eminent botanist as well as physician and traveller, was president of the College of Physicians, 1719 to 1735. An Irishman by birth, he studied medicine at Paris and Montpellier, and took his degree in the University of Orange; on his return to England he lived for a time with Sydenham, and practised as a physician in London, but in 1687 he accompanied the Duke of Albemarle to Jamaica, where he studied the natural history of that island.

His first volume appeared in 1707. He was deservedly elected president of the College of Physicians and of the Royal Society.

Dr. Moore's book is a most interesting and scholarly contribution to the history of medicine.

## THE CALIFORNIA EARTHQUAKE.

*The California Earthquake of* 1906. Edited by David Starr Jordan. Pp. xv+371; illustrated. (San Francisco: A. M. Robertson, 1907.)

THIS is a collection of nine well-written essays, which, as might be expected, more or less overlap in their subject-matter. The first of these, by the editor, deals almost entirely with the Great Fault or Rift, the sudden yielding along which caused the earthquake. The strongest motion was felt where the fault enters the sea, near to which hotels and houses were thrown into the water. A fact that there was some disturbance in the sea suggests that a portion of the origin was beneath the same. At one place a train was overturned. We read that persons in an undisturbed district looking towards one that was shaken may have seen rows of trees and rows of bushes filing past them. The earthquake, we learn, was not connected with eruptions in the Aleutian Islands. The author gives us lists of Californian earthquakes, the more destructive of which apparently have had a period of thirty to forty years. He is inclined to ridicule electrical theories as a cause of earthquakes, and in referring to the destruction which took place in town and country, he quotes from the book of Isaiah, which declares that "men shall be plagued by their own inventions."

The second essay is by Prof. Branner. It deals with the geology of the earthquake. He chiefly describes the Great Fault, which split both trees and houses. Prof. Derleth confines his remarks to the effect of the earthquake upon structures. Destructivity is marked along a belt 300 miles in length and fifty miles in breadth. Apparently there was an attempt to tell outsiders that San Francisco had only been visited by a fire, but Prof. Derleth thinks it will do San Francisco and California more good if it is admitted that there really was an earthquake. Santa Rosa, like San Francisco, had fire simultaneously with the earthquake. Varieties of buildings in San Francisco are described in a variety of terms. Some were honest, some dishonest; some were fire-traps, others fire-proof without but not fire-proof within. Destruction varied according to the nature of the ground on which buildings were placed. The failure of water-pipes and sewers is described in great detail. In short, this essay is a treatise on building, for which thirty-nine rules are given. With most of these we quite agree, but not with all. Rule 4 refers to brick chimneys, which, we are told, should be built of weak lime mortar. Built in this way, when the earthquake comes they will crumble and fall as individual bricks, but if built with rich cement they will fall *en bloc*, and crush through the roof. We admire what Prof. Derleth has done off his own bat, which, taken altogether, is certainly good, but we cannot help suggesting that he might with advantage have consulted the results which have been arrived at with regard to construction in countries other than his own.

Mr. G. K. Gilbert, of the U.S. Geological Survey, also describes the Great Fault, seventy-five miles from which the shock was observed by nearly all persons awake, but at 200 miles it was perceived by only a few. Mr. S. Taber, of the Stanford University, estimates the area of greatest damage as being a little more than 200 miles in length and forty miles in width. The intensity of the shock was greatest along the line of faulting, and the initial movement was parallel to the same.

Dr. F. Ōmori, of the Imperial University of Japan, gives us interesting notes with regard to several points not touched upon by other writers. He tells us that in San Francisco the greatest number of monuments were overturned towards the east; the ascertained number of persons killed in San Francisco was 300, while the total number of persons killed in the earthquake area was probably not more than 1000; the double amplitude of motion in San Francisco was about 4 inches, and the period was about 1 second. For twenty or thirty years, Central California may seismically be regarded as a very safe place.

The last article is a personal narration by Mary Austin. It is not intended to be scientific, but it contains sufficient epigram, pathos, and humour to make it well worth reading. The first words are, "there are some fortunes harder to bear once they are done with, than while they are doing." Later we read, "It is perfectly safe to believe anything anyone tells you of personal adventure; the inventive faculty does not exist which can outdo actuality." Speaking of intelligence that reads God behind seismic disturbance, the writer says that the actual damage done by God to San Francisco was small beside the damage that resides in man's contrivances. Man made things carry the elements of their own destruction.

J. MILNE.

## ELECTRIC RAILWAYS.

*Electric Railways Theoretically and Practically Treated.* Vol. ii., Engineering Preliminaries and Direct-current Substations. By Sydney W. Ashe. Pp. vi+282. (New York: D. Van Nostrand Co.; London: A. Constable and Co., Ltd., 1907.) Price 10*s*. 6*d*. net.

THIS is essentially a book for experts, and especially American experts. The English engineer may find here and there in the book some information that will be useful, but he must be an expert to understand it. On the title-page we read that this is "Volume Two," and that it deals with "Engineering Preliminaries and Direct-current Substations." By preliminaries the author means statistics as to the relations between the number of inhabitants in a town and their requirements in the way of travelling facilities.

The amount of statistical material brought together in the first few pages is very large, but as it refers exclusively to American towns it is almost useless to the European expert. The condition of the public roads, the scarcity of cabs, the hustling tendency of the business man, and the general tendency to ride rather than walk, all make for a greater development of travel facilities by tramway than on this side of the Atlantic, so that the figures given by the author would have to be used with great caution in estimating tramway requirements in Europe. Fortunately there is no need to use American figures at all, since sufficient data are available from European experience. A curve on p. 14 is interesting as showing that with the expansion of towns the mileage of electric lines per 1000 inhabitants goes down, and the yearly number of journeys made by each inhabitant goes up. The figures are not directly applicable to European towns, but the tendency shown by these curves is the same in Europe. Towns of about 40,000 inhabitants show the greatest mileage, namely 0·76 per 1000 inhabitants, but only 110 journeys per inhabitant yearly, whilst towns of one million inhabitants and above have on the average only half a mile of line per 1000, but each inhabitant uses the cars on an average 230 times a year.

It is not clear from the author's figures whether they refer to what we should term tramways or whether they include railways also; the latter is probable, for tables giving mileage, equipment, cost, and earning of electrified main lines are mixed up with the other statistics. The next three chapters are devoted to what the author calls "Electrical Features," and deal with motor capacity and running diagrams. Various methods for getting out these curves are given, namely, Armstrong's, Storer's, and Hutchinson's methods, the latter at some length. The treatment is by no means lucid, formulæ and coefficients being introduced without explanation. Unless the reader is a thorough expert in this subject (when he needs no further instruction from the author) he will make nothing of these chapters.

Altogether the author's mathematics is not characterised by exactitude. Thus, on a later page, when he treats of converters, following (with due acknowledgment) Mr. Hay's method for the determination of the output, we find him calling a line like the following

$$\tfrac{1}{4}I_d^2+\tfrac{1}{2}I_a^2-\tfrac{1}{2}I_a\int_0^\pi \cos 2\left(\alpha-\frac{\pi}{n}\right)\pm I_dI_a\int_0^\pi \sin\left(\alpha-\frac{\pi}{n}\right)$$

an equation, without saying what it is equal to, and omitting the differential $d\alpha$. It will also be noticed that the third term should contain either the product of two currents or the square of a current, so that the expression is also wrong in the matter of dimension. A reader having Mr. Hay's book at hand will perhaps be able to find his way through the author's mathematics, but without such aid he had better skip the part on p. 195.

The author seems to pin his faith to the system, almost universal in America, of transmitting by three-phase current and converting into continuous current by means of rotary converters in substations. Motor generators, direct working, or the use of boosting batteries are not even mentioned. The important matter of heating of transformers and means of cooling is dealt with in less than two pages of general remarks, but to make up for this we get plenty of catalogue pictures of plant installed by the two leading American companies. Chapter ix., treating of insulating oils, is instructive. On p. 234 a curve is given showing the enormous influence on the insulating property of the oil of even slight traces of moisture, and the specification given on p. 239 should prove useful.

GISBERT KAPP.

## OUR BOOK SHELF.

(1) *Algebraic Equations.* By G. B. Mathews, F.R.S. Pp. viii+64. (2) *The Theory of Optical Instruments.* By E. T. Whittaker. Pp. viii+72. Cambridge Mathematical Tracts, Nos. 6 and 7. (Cambridge: The University Press, 1907.) Price 2s. 6d. each net.

(1) THE solution of a given equation is a problem which has attracted the attention of many of the greatest mathematicians. In this tract we have a short summary of the results arrived at. The solution depends on the properties of a certain permutation-group called the Galoisian group; if this group is soluble, the equation is solvable by radicals. Interesting types of soluble groups are cyclical, Abelian, and metacyclic groups. To each of the corresponding equations is devoted a chapter in which are explained the application of cyclical groups to cyclotomy, the dependence of Abelian on cyclical equations, and Kronecker's solution of the metacyclic equation. Prof. Mathews's masterly epitome of the subject is not very easy reading, and he assumes some knowledge of Tschirnhausen's transformation, the theory of permutation-groups, &c. The student will probably have to prepare himself for the study of this tract by reading some more elementary treatise on the same subject (*e.g.* Dickson's "Algebraic Equations"), and some book on groups, such as Burnside's.

(2) Dr. Whittaker does not follow Prof. Mathews in writing for the advanced mathematician, but appeals in the first place to those students of physics to whom mathematics is interesting chiefly for its applications. The professed object is to give "a simple theoretical account of those defects of performance of optical instruments to which the names of coma, curvature of field, astigmatism, distortion, secondary spectrum, want of resolving power, &c., are given." Limitations of space necessitate in places proofs which, though clear, are rather too concise; but except for this the beginner will find the tract fairly straightforward reading. The author has succeeded in producing a book which will prove remarkably interesting, not only to the user of optical instruments, but also to any student of mathematics. The leading principles and results are very attractively presented, and can be readily grasped without plodding through every detail of the somewhat laborious approximations which the subject at times requires.

H. H.

*Detection of the Common Food Adulterants.* By E. M. Bruce. Pp. vii+84. (London: A. Constable and Co., Ltd., 1907.) Price 5s. net.

THE United States used popularly to be looked upon as *par excellence* the land of wooden nutmegs and similar examples of perverted manufacturing ingenuity. Perhaps, therefore, it is fitting that what our author calls "the great pure food reform" should find especial favour there. Be that as it may, there has undoubtedly arisen in the States a quickening of interest in the matter of food adulteration; wherefore Mr. Bruce speaks of health officers, food inspectors, chemistry teachers, and even students being constantly called upon to test the purity of various foods—at whose instance is not quite clear. He proposes to help them and others in this task, which he says "usually involves nothing more than making simple qualitative tests for adulterants," by bringing together in one small book the best and simplest qualitative methods of detecting all the common sophistications of foodstuffs.

As a collection of recipes the work is good; in other respects it commands but qualified admiration. For the glorified cookery-book in chemical literature we have no great liking, and this compendium of "tests" is little more. The numerous pitfalls which beset the unwary are rarely indicated in the directions given; and the reasons for the various operations are left for the operator to discover for himself. Now this is well enough if the person using the book is already a master of his craft, knowing the pitfalls and how to avoid them, cognisant of the why and wherefore of his procedure, and only employing the work as a convenient collection of notes wherewith to refresh his memory when applying the various processes. But in the hands of the unpractised person, whether student or "inspector," it is quite another matter. Differences of conditions, apparently slight, may lead him wholly astray. It would be well enough for the enthusiastic student or teacher to test his breakfast bacon for borax, or his morning milk for added water, provided he does it merely for his private information; only in that case it would not benefit the pure-food movement much. But if he is going to lodge a serious complaint on the strength of his discoveries, it would be well, also, first to have those discoveries confirmed by a practised analyst. Otherwise there may arise unpleasant references to the law of libel.

The experiments are well selected and tersely described. As a compendium of some of the best qualitative tests for ordinary food-adulterants the book will be useful, especially to the man who already knows how to apply the processes. C. S.

*Altitude Tables.* Computed for Intervals of Four Minutes between the Parallels of Latitude 0° and 30°, and Parallels of Declination 0° and 24°. Designed for the Determination of the Position Line at all Hour Angles without Logarithmic Computation. By Frederick Ball. Pp. xxxiii+245. (London: J. D. Potter, 1907.) Price 15*s*. net.

SINCE the notice of the first part of this work appeared in NATURE of February 20, the companion volume for latitudes 0° to 30° has been published, making these tables complete between the parallels of 60° N. and 60° S. By their means the navigator can with facility and rapidity determine his position by the observation of any heavenly body the declination of which does not exceed 24°, and, as the latitude and declination are interchangeable in the tables, they are consequently available for all stars up to 60° in declination between 24° N. and 24° S.

This valuable contribution to scientific navigation will be appreciated by all navigators who employ the "New Navigation"—Captain Marcq St. Hilaire's method—as a practical and direct help in saving the tedious computation of the altitude required in the problem. The tables will undoubtedly tend to popularise that excellent method, which has hitherto been neglected by so many navigators, mainly on account of the lengthy calculations entailed, and more especially when it is realised that their practical utility equals their mathematical exactness.

The introduction to each volume fully explains the various uses of the tables, so that no difficulty need be experienced when employing them. The book is of a handy size and well bound, with clear type well arranged and spaced, so that the navigator with but little light and limited time will find a pleasure in using it. MIREMONT.

*Logarithmic and Other Tables for Schools.* By Frank Castle. Pp. 36. (London: Macmillan and Co., Ltd., 1908.) Price 6*d*.

THE introduction of more practical methods in the teaching of mathematics in schools has led to an increasing demand for inexpensive tables of logarithms, values of trigonometric functions, and other data which pupils are now encouraged to use at quite an early stage of their mathematical work. Mr. Castle has compiled a series of four-figure tables which will meet every need of mathematical classes in schools, and be of great service in school laboratories. The tables include logarithms and antilogarithms, natural and logarithmic sines, cosines and tangents, degrees to radians and radians to circular functions, hyperbolic logarithms, powers, roots and reciprocals, and exponential and hyperbolic functions. The type is clear and the style attractive, and these qualities, combined with the wide scope and low price, should ensure a wide popularity for the tables.

*Praise of a Simple Life.* Edited by E. A. Baker. Pp. x+258. (London: George Routledge and Sons, Ltd., n.d.) Price 2*s*. 6*d*. net.

MR. BAKER has compiled a collection of extracts on the theme of a life according to nature from classical writers to the end of the eighteenth century. These utterances are arranged in four sections, which the editor calls respectively the antique world, the dawn of a new age, the age of expansion, and the age of reason. More than four-score authors are drawn upon, so that the reader is provided with a diversity of points of view. The volume is dainty, will go into the pocket, and should be a favourite with readers of poetic temperament.

## LETTERS TO THE EDITOR.

*[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.]*

### On the Radio-activity of Potassium and other Alkali Metals.

IN the course of some experiments made by them on the radio-activity of a series of salts which had hitherto been considered inactive, Messrs. Campbell and Wood (Proc. Camb. Phil. Soc., vol. xiv., part i., p. 15, 1907) found that potassium salts exhibited a radio-activity greater than that of any other substance previously examined which did not contain any of the so-called radio-active elements.

In seeking for the source of this activity, these experimenters found it impossible to separate out any active impurity from the salts examined, and they were led by the results of their investigation, which included measurements on the activities of a limited number of the compounds of potassium, to conclude that the activity originated with the potassium itself, and was an atomic property of that metal.

In a later paper (Proc. Camb. Phil. Soc., vol. xiv., part ii., 1907) Campbell described some additional experiments dealing with the character of the radiation emitted by the potassium salts, and in concluding expressed the opinion that the radiation consisted of $\beta$ rays possessing an average velocity less than that of the $\beta$ rays of uranium.

During the last few months the writer, in collaboration with Mr. W. T. Kennedy, has made, in the Physical Laboratory at Toronto, a close examination of the radioactivity of a large number of potassium and other salts, and while the results of this examination confirm the discovery of Campbell and Wood that potassium salts generally possess an exceptionally high activity and emit a radiation possessing considerable penetrating power, they do not support the conclusion that the activity of these salts is a *normal* atomic property of potassium, and that it is always directly proportional to the amount of that metal present in the salt.

In measuring and comparing the activities of the different salts, these were spread in turn in thin regular layers on a shallow tray, which was placed on the bottom of an ionising chamber 40 cm. long, 26 cm. wide, and 28 cm. deep. The saturation currents through the air in this chamber were measured with a sensitive quadrant electrometer, and were taken as measures of the activities of the different salts. Experiment showed that the saturation current increased with the thickness of the salt layer up to between 2 mm. and 3 mm., and for greater thicknesses remained constant.

The investigation included the examination of some thirty specimens of potassium salts, and thirteen samples of the salts of the other alkali metals. As a result of this examination it was found :—

(1) That samples of a selected potassium salt obtained from different sources exhibited widely differing degrees of activity. Two chlorides of potassium, for example, were found to differ by more than 40 per cent. in their activities, and two of hydroxides by an almost equal amount. In the case of cyanide of potassium, the variation in activity was especially marked, as two samples of this salt exhibited activities which were approximately only 5 per cent. and 20 per cent. respectively of that shown by a number of other samples of the same composition. A sample of potassium sulphite, too, was found to possess an extremely small activity.

With the majority of the salts, however, the variations were not so marked, but the differences observed, even when due allowance was made for the varying densities and states of division of the salts, were so extensive and of such magnitude as practically to preclude the view that the activity of potassium and its salts was connected with a *normal* atomic property of the metal.

(2) That while metallic sodium and several sodium salts did not exhibit the slightest trace of activity, some samples of sodium chloride, obtained in the form of rock salt, showed an activity comparable with that exhibited by a number of the potassium salts. This result, taken in conjunction with the low value obtained by Elster and Geitel in their measurements on the conductivity of air in a salt mine, would indicate that very probably some active impurity was present in the samples of rock salt examined.

(3) That with the exception of ammonium chloride, which exhibited a feeble activity, none of the lithium and ammonium salts examined showed the slightest trace of radio-activity; that a sample of rubidium alum was found on examination to exhibit an extremely small activity, and that a sample of cæsium chloride exhibited one which was only just measurable.

J. C. McLennan.

University of Toronto, April 15.

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## Chemical Analyses of Water from Dew Ponds.

I have been interested in the reviews of books and articles which have appeared in Nature from time to time on the subject of dew ponds; and it occurred to me that the chemical analysis of the water of these ponds would help to settle the question of the origin of the water. This is a method used to some extent by sanitary authorities. I have had the opportunity of obtaining some specimens of water from different districts, and the specimens have been analysed by Mr. Claude Saville Grace, one of the students at this institute.

The first specimen (*a*) came from a dew pond on the southward down to the north of Ramsbury, Wiltshire. The pond is on the flat upland near the 693-feet mark on the 1-inch Ordnance map south of Aldbourne. The formation is chalk, so that analysis would immediately settle the point as to whether the water had come through the chalk or had been condensed from the air. The other two specimens, (*b*), (*c*), come from St. Boniface Down, north of Ventnor, Isle of Wight. The pond (*b*) is near the 787-feet mark, almost at the highest point of the down; the second pond (*c*) is on the neck between St. Boniface and Shanklin Downs. The downs are chalk masses lying on Greensand rock. I have added the analysis of the St. Boniface spring water, a spring on the south side of the down facing Ventnor, about 450 feet above sea-level. It is locally known as a wishing well, and its chemical peculiarity is that it contains sulphuretted hydrogen in small quantity. It undoubtedly comes out of the chalk, and the sulphuretted hydrogen is due to the decomposition of pyrites which occurs in masses in the chalk.

| | $CaCO_3$ parts per 100,000 | Cl parts per 100,000 | |
|---|---|---|---|
| (*a*) Ramsbury pond ... ... | 3·6 ... | 0·75 ... | inland |
| (*b*) St. Boniface pond ... ... | 4·3 ... | 3·5 ... | near sea |
| (*c*) Shanklin pond ... ... ... | 7·7 ... | 3·4 ... | .. |
| (*d*) St. Boniface Wishing Well. | 23·9 ... | 7·3 ... | traces $H_2S$ |

The quantities of $CaCO_3$ indicate to me that the waters are, in the cases (*a*), (*b*), (*c*), condensed waters which have been lying in the pond sufficiently long to take up a little $CaCO_3$. The ponds near the sea show increased chlorine, probably from salt spray blown up from the sea. The sulphuretted hydrogen shows the origin of the wishing-well water in the deep chalk.

To me there is very little doubt that all three ponds are simply water butts in which rain water is stored. Inspection of the ponds shows that they have much larger catchment areas than simply the water area, and the area is generally more than nine times that of the pond. We have to remember that for circular ponds and catchment areas of radii 1 and 3 respectively a rainfall of 20 inches would mean a depth of 180 inches (15 feet) when collected into the pond area, so we can easily understand the presence of water all the year round under these conditions.

It is interesting to note that a fresh-water pond is easily distinguished from the hard-water pond by the waterweed growing in the former. I have noticed the same carex in all the fresh-water ponds.

Sidney Skinner.

South-Western Polytechnic Institute, May 8.

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## The Reflection of Distant Lights on the Clouds.

I do not know whether observations have ever been made to determine how far the reflection of distant lights on the clouds may be seen. It may possibly, however, be of some interest to know that the lights of London may at times be seen in this way at a distance of at least fifty miles. At 11 p.m. on April 30 the reflections of the lights of several neighbouring towns were unusually bright as seen from here. The altitude of the Portsmouth glare was about 10°; the distance of the centre of Portsmouth is about 12·5 miles; the cloud height was therefore about 2·2 miles. Over Hindhead and Blackdown a bright band of light was visible. Circumstances prevented me from measuring its altitude, but I estimated it as one or two degrees. Now London lies exactly in this direction, and fifty miles would bring one to the well-lighted area of south London. If the cloud height were uniform, the altitude of the reflection at this distance should have been a little more than 2°. The only other large town in the same direction is Guildford; the altitude of its glare should have been 5°. I do not think I could have made so large an error in estimating the altitude, but apart from this the Guildford glare would not stretch along the horizon for more than 2°, while the observed band of light stretched for at least 10°, and possibly more, for trees bounded the view to the west and the downs to the east.

Charles J. P. Cave.

Ditcham Park, Petersfield, May 9.

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## Jupiter's Eighth Satellite.

The discovery at Greenwich Observatory of Jupiter's eighth satellite, its great distance from the planet, and its retrograde motion, have excited the interest of the astronomical world.

Until more extended observations have led to a more certain knowledge of the orbit, speculation is premature. But it is impossible to resist the conjecture that there is a bare possibility that the object is really the long lost Lexell's comet, which in 1770 was describing an elliptic orbit with an eccentricity of 0·7858, with a periodic time of $5\frac{1}{2}$ years, in a plane inclined 1° 34′ to the ecliptic; the next return of which it was impossible to observe from the earth's position; which about 1779, August 23, approached Jupiter within 0·01 of the earth's mean distance from the sun; and which has not been again observed.

At that distance Jupiter's attraction exceeds that of the sun in the proportion of at least 200 to 1, and the distance from one of the satellites may have been very small. In this way it is not altogether impossible that the comet may have been diverted into an elliptic orbit round Jupiter, and a retrograde motion round the planet would be as likely as a direct motion to ensue. The intervention of a satellite is essential, and this, combined with the observed large angular distance from Jupiter in one part of its orbit, implies a large eccentricity. Should further observations reveal a moderate eccentricity, the impossibility of identity between this satellite and Lexell's comet will be proved.

The Athenæum, May 6. GEORGE FORBES.

### The Corrosion of Iron and Steel.

IN a letter to NATURE of April 16, Dr. Frank Clowes states his belief that pure lead will dissolve to a slight extent in perfectly pure water "as iron did in the experiments made by Whitney and repeated by the American investigators, when they brought iron into contact with water under conditions similar to those which I had secured."

The American investigators here referred to are W. H. Walker, Cederholm, and Bent, who have recently studied the process of the rusting of iron (Journ. Amer. Chem. Soc., 1907, xxix., p. 1251), and agree with Whitney in regarding the whole subject as an electrochemical one.

With reference to the behaviour of lead in contact with water, I have nothing to say, for although the study of the corrosion of metals has been pursued by me for several months, my observations have not as yet been extended to lead. I wish to point out, however, that if this metal does dissolve to an appreciable extent in water as Dr. Clowes suggests, then the analogy adopted by this gentleman is open to criticism. I have made a very careful study of the process of the rusting of iron, and my results point conclusively to the fact that it is primarily the result of acid attack. These results will, I hope, shortly appear in print; it is unnecessary, therefore, to enter into any detail here. Nevertheless, one or two general remarks may prove of interest.

Walker and his co-workers found that if water in which iron has been boiled is concentrated to a few drops, the presence of iron can be detected by chemical means. It is clear that if the concentration of the iron in solution can be increased by the evaporation of the water, as these authors say, the same result should be obtained by protracted boiling of the water and iron, keeping the volume of the former constant by using a reflux condenser.

My experiments show, however, that such is not the case. The presence of traces of iron discovered by Walker, Cederholm, and Bent is not, therefore, to be ascribed to the action of pure water alone, but to that of traces of dissolved carbon dioxide.

In a very interesting series of investigations, Leduc (*Comptes rendus*, 1906, cxlii., p. 149) has recently shown that all the dissolved air cannot be expelled from water by the mere process of boiling. He further calculates that at least 1 c.c. of gas remains in a litre of water even after thorough boiling. Since carbon dioxide is not only much more soluble than oxygen and nitrogen, but also combines with the water to form carbonic acid, it is not unreasonable to suppose that a considerable percentage of this residual gas is carbon dioxide. This will effect the solution of a trace of iron. Although this quantity may be too minute to detect at once by chemical means, its concentration can be greatly increased by evaporating to small bulk, when the characteristic reactions for iron may be obtained. On the other hand, protracted boiling with reflux condenser cannot increase the concentration of the iron, since the amount of carbon dioxide remains the same. The extreme difficulty of removing all traces of this gas from water is not generally realised by chemists, and the precautions adopted by Walker and his co-workers were not sufficiently refined—hence their results. A single molecule of carbonic acid is sufficient, theoretically, to cause the corrosion of iron (see my remarks, NATURE, September 27, 1906), and I have shown that in practice a very few molecules are operative.

There can be no reasonable doubt, therefore, that the electrolytic theory is wholly inadequate.

In a letter to NATURE of October 11, 1906, Mr. Richardson asks if the rusting of iron is not caused by bacterial agency. As no reply has been given, it may not be out of place to deal with the question here. The suggestion is not new. Schorler, Beythien, Adler, Raumer, and others have directed attention to a bacterium, *Gallionella ferruginea*, which obtains its life energy by oxidising ferrous carbonate or organic ferrous salts with the precipitation of rust. But no organism has been found capable of feeding on metallic iron. Indeed, if one such were found, it would have to effect the solution of the iron by some presumably acid secretion, and this brings us back to the acid theory of rusting.

J. NEWTON FRIEND.

### Fault Lines in the Atlantic.

IN Prof. J. Milne's discourse at the Royal Institution which appeared in NATURE of April 23 is given an interesting map on p. 593 showing the folds and probable direction of fault lines in the Atlantic. In that map is shown the mid-Atlantic "rise" extending to about 40° S. The map, however, would have been more interesting had Prof. Milne included in it the recent bathymetrical researches of the *Scotia*, which were described in a preliminary paper in the *Scottish Geographical Magazine* in August, 1905. Here it is shown that the Scottish expedition sounded out this "rise" for a thousand miles further south than Prof. Milne has marked it, and also that that "rise" has probable connection with another running in a more or less E.N.E. and W.S.W. direction from the south of South America through South Georgia and the Sandwich Group, and also from Graham Land, Antarctica, through the South Orkneys and the Sandwich Group, thence passing eastward through Bouvet Island to Madagascar and the east coast of Africa. The extension of the mid-Atlantic "rise" continues the reflection of the South American continent, and again the transverse "rise" reflects the hypothetical and known portions of the coast-line of Antarctica. WM. S. BRUCE.

### The Pollination of the Olive.

As Knuth's great work on flower pollination, compiled from all available sources, says nothing whatever about the olive, I recently asked Prof. J. E. Coit, of Arizona, to look out for insects upon the flowers. He carefully examined many olive trees in flower at Tucson, and did not find a single insect at the flowers, with the exception of a thrips (apparently *Euthrips occidentalis*, Pergande), which occurred in great numbers. He kindly sent me some twigs with the Euthrips upon them, and I was able to observe that these insects were profusely dusted with pollen. No bees were seen at all. Prof. Coit adds:—"Olive pollen is formed and shed in such enormous quantities that I think the wind among the branches is the chief agent in pollination. If you jar a large branch of olive while it is in full bloom, a perfect cloud of *green* pollen will be seen to float away on the breeze."

Arizona, however, is not the original home of the olive, and the purpose of this note is to suggest that those who have an opportunity to see the plant in bloom in Mediterranean and other countries should make some observations.

T. D. A. COCKERELL.

University of Colorado, May 2.

### The Coloration of Birds' Eggs.

I SHOULD be very grateful if anyone could tell me whether there is anything known with regard to the egg-colour of birds. Is there here, by any chance, a field for investigation which may throw light upon the so-called Mendelian phenomena? Or is there yet any explanation of how the egg becomes coloured, or why?

66 Hallam Street, W. R. L. LESLIE.

## THE CRUISES OF THE "VALHALLA."[1]

IN taking with him as collector on the *Valhalla* a young naturalist and presenting the specimens obtained to the British Museum, Lord Crawford has set an excellent example to all yacht-owners who, from considerations of health (as in his Lordship's own case) or pleasure, enjoy the opportunity of cruising leisurely among islands of which the natural history is still imperfectly known. Not only does the systematic collecting of natural history specimens add largely, if undertaken in an appreciative spirit, to the interest and pleasure of such a cruise, but it may, as in the present instance, add very appreciably to zoological knowledge. For during two of the *Valhalla's* cruises, described in the present volume, no fewer than eleven birds were obtained, which in the opinion of the British Museum experts are entitled to rank as new species.

In obtaining the services of Mr. Nicoll as naturalist, the owner of the *Valhalla* may be considered to have been specially fortunate, as the book before us is evidently the work of an acute observer, who knows what to look for, and how to describe in readable language what he has seen. The selection appears indeed to have been fortunate in more ways than one, for the training and experience acquired during the three cruises doubtless aided Mr. Nicoll in obtaining his present post at the Giza Zoological Gardens, where he has every prospect of a successful career.

The first and longest voyage, during which no fewer than 38,000 miles were covered, consisted of the circumnavigation of the African continent, to which, however, a wide berth was given on the west side, where the vessel touched the Brazilian coast at Bahia. The second cruise was to the West Indies and back, during which the ornithology of the Caiman Islands was worked as fully as circumstances permitted; while the third and last was a voyage round the world, in the course of which the yacht touched at quite a number of interesting islands, including the Comoros, Seychelles, Aldabra, and Tristan da Cunha. It was this voyage that afforded by far the great majority of the new birds; while it is also the one which has acquired a historical celebrity on account of the sight of the "sea-serpent" off the Brazilian coast. Since reference has been made to this incident on a previous occasion in NATURE, it will be unnecessary to make special comment in this place, except to mention that Mr. Nicoll now expresses, apparently for the first time, his belief that the creature was a mammal.

At Punta Arenas the author was asked 50*l.* for a small fragment of the skin of the now well-known ground-sloth of the cavern of Ultima Esperanza—an offer which gives him the opportunity of stating that the creature is almost certainly extinct, as otherwise specimens would have been killed and offered for sale by the natives. If we have to abandon all hope of seeing a live ground-sloth, it is satisfactory to learn that the giant tortoises of Aldabra are still to the fore. On Aldabra itself there are only a few remaining, which the party was unable to visit, but in the Seychelles a number are now kept in a walled enclosure at Government House. While some were of huge size, others were but recently hatched; and it seems that these reptiles breed freely in captivity, and that all the islands of the group have tortoise-farms.

Another noteworthy event of the third voyage was a visit to Marie Louise Bay, in Praslin Island, Seychelles, for the purpose of inspecting the famous "coco-de-mer" trees, which grow in a small valley above the bay, and are found in a wild state nowhere else in the world. The author was informed that the huge nuts take many years to mature; while practical experience convinced him that even when they reach that stage their contents are insipid, and far inferior to the ordinary cocoanut.

"Coco de Mer" Trees, Praslin Island, Seychelles. From "Three Voyages of a Naturalist."

Did space permit, reference might be made to many other interesting passages in Mr. Nicoll's volume, which, although containing little that is absolutely new, may be commended as a well-written narrative of the experiences of an eager naturalist in remote islands.

R. L.

[1] "Three Voyages of a Naturalist; being an Account of many little-known Islands in Three Oceans visited by the *Valhalla*, R.Y.S." By M. J. Nicoll. Introduction by Right Hon. the Earl of Crawford. Pp. xxvi+246; illustrated. (London: Witherby and Co., 1908.) Price 7*s.* 6*d.* net.

## ALBERT DE LAPPARENT.

GEOLOGISTS throughout the world will be grieved to hear that one of the best known and most illustrious of their number, M. de Lapparent, has passed away after a brief illness. It seems but yesterday since, with so notable a company of his fellow-countrymen, he attended the centenary celebrations of the Geological Society here, apparently in the fulness of health, and with still many years of vigorous life before him. Lately, however, he had not been well, and for a time his condition had even given cause for some anxiety. But the danger seemed to have passed off, and his friends hoped soon to welcome him back to his place at the Academy of Sciences in Paris. But a rapid change for the worse supervened, and he died in the early part of last week at the age of sixty-seven years.

The loss sustained not only by geology, but by science at large, through the death of so accomplished a writer cannot at once be fully appreciated. It was not so much by the extent of his contributions to original research as by the philosophical discussion of all contemporary investigation regarding the history of the earth that he gained the commanding position which he held for so many years. His well-known essay on the Pays de Bray, published in 1879, proved what he could have achieved had he devoted himself to field-work. His "Traité de Géologie," which first appeared in 1881, showed the full bent of his genius by its luminous presentation of every department of the science, its admirably logical arrangement, and its characteristic elegance and clearness of style. The first edition formed a single volume, but in the course of a quarter of a century it was continually augmented and enriched, until, when the fifth edition was issued two years ago, it formed three volumes, with an aggregate of more than 2000 pages. This noble treatise will remain as its author's best monument. It has taken its place as an indispensable book of reference and suggestive guidance to every student of modern geology, and it will in future years be consulted as an ample exposition of the condition of the science at the beginning of the twentieth century.

The later editions of the "Traité," among many improvements and additions which the author's wide range of reading enabled him to make, have especially been marked by the numerous maps introduced into the text in illustration of the geographical features of different regions in successive geological periods. Following up the brilliant outlines of Neumayr and the generalisations of Suess, M. de Lapparent embodied in definite charts what he conceived to have been the distribution of land and sea throughout the ages of the earth's history. No one can peruse these restorations without a sense of the enormous amount of research which they involved in the published geological literature of every part of the globe. Although they could only be tentative, for the data obtainable are often meagre and not always trustworthy, yet as sketches of what may have been the geography of the earth's surface in the remote past they are replete with interest and suggestiveness. The author's other minor text-books on geology, mineralogy and physical geography, distinguished, as they are, by the same lucidity of arrangement and elegance of expression, have been of the greatest service in furthering the progress of these branches of science in the general advance of education.

There was something eminently attractive in de Lapparent. His gentle and kindly manner drew men of all nationalities to him. His charm as a speaker led to his being continually called upon to address an assembled company. The well-modulated voice, the felicitous choice of words, and the flashes of humour made his speeches delightful to listen to. Under a playfulness of conversation he would from time to time reveal the depths of his serious nature. He was an eminently religious man, and sacrificed not a little in life for the sake of his convictions. No temptation could induce him to abandon the Institut Catholique, where from its foundation he continued to be one of its pillars of strength. So widely recognised were his personal qualities as well as his scientific distinction and his literary accomplishments, that on the death of Berthelot last year the Académie des Sciences could find no more fitting successor as secrétaire perpétuel than Albert de Lapparent. By his death the cause of science has been deprived of one of its most strenuous and successful advocates, and those who were privileged with his friendship have to mourn one whose memory they will never cease to cherish.

A. G.

## M. ALBERT LANCASTER.

M. LANCASTER, whose death was announced recently, was connected with the Royal Observatory of Belgium for so many years that it is impossible, as it would be undesirable, to disconnect his career from that of the institution he served so well. He saw the observatory grow in extent and reputation under several directors, from Quetelet to Lecointe, and gave loyal and devoted service to each. The site shifted from Brussels to Uccle, where a new and modern observatory replaced the modest building that long did duty, but M. Lancaster remained true to its fortunes. With the change of building and with the enlargement of its usefulness, M. Lancaster had to adapt himself to new conditions, but throughout the continual onward development, his energy and industry contributed not a little to the maintenance of the prestige of the observatory with which he was so long connected.

In three distinct ways M. Lancaster deserved well of science and his countrymen. In his capacity of librarian to the observatory, he appreciated the rapid extension of astronomical literature, and early recognised the desirability of making known to all what had been accomplished by individual effort, and of placing at the disposition of those who were engaged in a particular inquiry the results achieved by others similarly engaged. He took steps to give practical effect to this view, and not only did he publish several useful time-saving compilations, but he was led to the collection and arrangement of a vast mass of information, which in collaboration with the late director, M. Houzeau, was issued as an astronomical bibliography. Later and more complete compilations have necessarily superseded these early efforts, but Houzeau and Lancaster were the first to make any serious attempt to bridge the interval that separated the work of Lalande in 1802 from that of modern times.

Again, by the encouragement and assistance he gave to amateurs, M. Lancaster did much to create an interest in meteorology and astronomy throughout Belgium. He founded and edited the popular review, *Ciel et Terre*, which made the study of physics and astronomy attractive to the many, and fostered the true spirit of scientific inquiry. He gave to this periodical, which first appeared in 1880, the closest attention, wrote many articles for its pages, and by his enthusiasm made it not only a vehicle for the diffusion of information, but the means of encouraging a vast amount of amateur work in very varied directions.

Lastly, since 1898, he became director of the Meteorological Department of the Royal Observatory, and the successive volumes that have appeared bearing upon the climatology of Belgium testify to his skill and energy. He was well qualified for this position because meteorology had for him many attractions. As early as 1876 he tried to give greater uniformity to the method of meteorological observing by publishing a code of instructions for observers, and throughout an active life he exhibited a keen interest in this branch of physics. His rain-chart of Belgium is a specimen of what he could accomplish by ingenuity and painstaking industry.

If M. Lancaster's services were not brilliant, they were persistent and practical. He admirably filled the position in which he was placed, and by his comparatively early death at the age of fifty-nine years the observatory has lost a capable and devoted servant. In his lifetime his scientific ardour was adequately acknowledged. He was a member of many learned societies at home and abroad, and in addition to being Chevalier de l'Ordre de Léopold, he was decorated with the Ordre de la Couronne du Congo, La Croix civique de 1re Classe, and la Croix commémorative du Règne de S. M. Léopold II.

## *NOTES.*

THREE years ago the late Sir Michael Foster described in these columns (vol. lxxi., p. 443) the foundation by Prof. A. Mosso of the Col d'Olen Laboratory, at an altitude of 3000 metres on the southern slopes of Monte Rosa. On that occasion it was pointed out that the financial condition of the laboratory left much to be desired, and the hope was expressed that Prof. Mosso would secure ere long the necessary additional funds required. We are glad to learn, from a pamphlet descriptive of recent work at the laboratory, that the income of the institution has improved greatly, the subscriptions now reaching 117,504 francs, being very near the 120,000 francs originally considered necessary. It has been decided that the affairs of the laboratory shall be administered by a committee consisting of the professors of physiology, botany, and hygiene in the University of Turin, with the president and treasurer of the Italian Alpine Club. Prof. A. Mosso is the president, and Prof. O. Mattirolo the secretary. As was mentioned last week, two places in the laboratory are reserved to England, on the nomination of the Royal Society. Applications for a place should be made in the first instance to the Royal Society.

WE regret to see the announcement of the death, in his eighty-fourth year, of Prof. K. Möbius, professor of zoology in the University of Berlin.

ON Thursday next, May 21, Dr. Alexander Scott will deliver the first of a course of three lectures at the Royal Institution on "The Chemistry of Photography."

PROF. A. LAWRENCE ROTCH, the founder and director of Blue Hill Meteorological Observatory, Massachusetts, U.S.A., has been elected an honorary member of the Royal Meteorological Society.

A REUTER message from Athens announces that the German Emperor has presented Prof. Dörnfeld, head of the German Archæological Institute there, with a sum of 5000 marks (250*l.*) for the purpose of starting excavations on the site of the ancient Pylos.

AT the meeting of the National Academy of Science held in Washington on April 23, the following foreign associates were elected:—Prof. Svante A. Arrhenius, Stockholm; Prof. J. Larmor, Sec.R.S., Cambridge; Dr. Ivan P. Pavlov, St. Petersburg; Prof. Hugo R. van Seeliger, Munich; and Prof. T. Barrois, Lille.

THE death is announced of Dr. Hermann Wedding, professor of metallurgy at the Berlin School of Mines. He was an honorary member of the Iron and Steel Institute, and in 1896 received the Bessemer gold medal of that society. He translated Dr. Percy's works on metallurgy into German, and was the author of a large number of important metallurgical treatises.

THE Paris correspondent of the *Times* states that, within a year, in virtue of a contract with a French firm, Spain is to be provided with wireless telegraphy stations. The Canaries and the Balearics are to receive, respectively, seven and two stations, which will keep them constantly in touch with the fifteen stations of the Peninsular coast. It is anticipated that radio-telegraphic communications will shortly be arranged between Pernambuco and Tenerife. In that case the Spanish stations will form a link between Europe and South America.

IN the Journal of the Franklin Institute (vol. clxv., No. 4) Dr. Persifor Frazer traces the history of the Franklin Institute from its foundation in 1824 to the present time, giving portraits of the eminent men who have helped in the development of the society. A subscription of 50,000 dollars, given to the building fund by Mrs. Anna W. Walker in memory of her father, has assured the institute a new lease of life under greatly improved conditions.

THE death is announced of Mr. Caleb Barlow, chief preparator of fossils in the British Museum (Natural History). Mr. Barlow entered the British Museum as a mason in 1874, and gradually acquired remarkable skill in the preparation and restoration of fossil skeletons. He was especially successful in mounting imperfect specimens and modelling missing parts to complete them. Much of his unofficial time was devoted to other institutions, and examples of his skilful work are to be found in many museums.

THE *Comptes rendus* of the Paris Academy of Sciences for May 4 contains a communication, by M. Alfred Angot, with respect to the application of wireless telegraphy to the forecasting of the weather. The communication is practically amplifying the note by M. Bigourdan, to which reference was made in NATURE of May 7, and gives a *résumé* of the present situation. It is mentioned that for the last year the Meteorological Office has received each day wireless messages from several ships, the information being regularly published in the Daily Weather Report. M. Angot states that this information adds somewhat to our knowledge of the state of the atmosphere over the Atlantic. He directs attention to the report of Dr. Shaw on this subject to the International Meteorological Committee at Paris in September, 1907. It is pointed out that the obstacle to the extension of the use of wireless messages for weather forecasting is one purely of finance, and the necessary expense precludes the English and French weather offices from taking full advantage of the opportunity afforded.

"THE Daylight Saving Bill," which passed its second reading in the House of Commons on March 26, and is now before a committee of the House, proposes that early on the morning of each of the first four Sundays in April all the public clocks shall be set forward twenty minutes and be set back twenty minutes on each of the first four Sunday mornings in September. Cape Town has been cited as an example to show how easily the origin of public time can be changed. But Sir David Gill shows, in a letter in Tuesday's *Times*, that even to change the origin of time once for all requires careful preparation, and that to make changes in the manner proposed by the Bill must lead to confusion. Instead of adopting this method of making use of daylight hours, Sir David Gill suggests a change in our national habits and customs, such as was advocated in an article in NATURE of February 20 (vol. lxvii., p. 372). He points out that if, for example, the Bank of England could be persuaded to open business at 9 a.m. instead of 10 a.m. from April 1 to the end of September, no doubt all other banks and offices would follow suit, and if employers of labour would open their works an hour earlier in the spring and summer months the objects of the Bill would be in great part gained without difficulty or confusion.

THE news of the death on May 10 of the Rev. Father Eugene Lafont, S.J., C.I.E., has been recently notified from India, and will be received by his numerous friends with great regret. He died in Darjiling, the hill station of Bengal, to which place he went some little time ago. His age was seventy-one years, and he lived almost continuously in Bengal, with perhaps one visit to Europe, for about forty-three years. Father Lafont will long be remembered in Bengal for his distinguished scientific attainments and for the enthusiastic zeal with which he fostered the study of practical science by every means in his power among Indian and Eurasian students. He was, however, an educationist rather than an original thinker or original worker, but he did yeoman service for science in Bengal. For many years he was professor of physical science at St. Xavier's College, in Calcutta, and afterwards he became rector of the same institution. This college is one which makes provision for the education of the domiciled European and Eurasian population of Calcutta and Lower Bengal, and in this way Father Lafont secured great influence among these classes. The college is also popular with native Indian gentlemen, and by his influence with Rajahs and other men of note Lafont was able to obtain several endowments for the purchase of scientific apparatus. This college possesses an excellent supply of most costly lecture apparatus, especially of the kind necessary for popular lecture demonstration, in which way that college is better equipped than any other in India. Indeed, in addition to his sterling qualities as an educationist, Father Lafont was a born popular scientific lecturer, and had a peculiar facility for putting dry facts in a popular way and an equal facility for making his lectures interesting by excellent experimental illustrations. For more than thirty years he was a prominent fellow of the Calcutta University, both under its former and its present constitution, and he held a number of prominent honorary posts under it, while his influence is to be found in many of the science courses of study as at present arranged. He was always held in the greatest respect and esteem by all his fellow-workers, and was most popular with all Indian gentlemen. It was to a considerable extent owing to his cooperation and influence that the late Dr. Mahendra Lal Sarkar, C.I.E., was able to start, some thirty years ago, a society called the "Indian Association for the Cultivation of Science" in Calcutta, an association which is still doing very useful work in diffusing scientific knowledge among various classes of Indian gentlemen. Father Lafont was for many years an active supporter of this society, and was one of its honorary lecturers, and later on became its vice-president. His name will thus be long kept in mind as that of one of the pioneers of scientific education in Bengal, and his death is hence a great loss, especially at this time, when strenuous efforts are being made to put education in Bengal on a satisfactory basis.

WE have to acknowledge the receipt of the ninth fasciculus of the "Fauna of New England," now in course of publication in Occasional Papers of the Boston Society of Natural History. It is devoted to a list of the spiders (Araneida), which has been drawn up by Elizabeth B. Bryant, and comprises 309 definitely recognised species, together with about a dozen others which are at present unrecognised.

WE are indebted to the author, Dr. E. Balducci, for a copy of a paper entitled "Morfologia dello Sterno degli Uccelli," published by C. and G. Spighi, of Prato, at the price of five lira. It is illustrated by a large number of figures of the sternum in a numerous series of nocturnal and diurnal birds of prey. After discussing the bearing of the characters of this part of the skeleton on the relationship of the Striges to the Accipitres, the author points out that not only can the different species of these two groups be recognised by means of the sternum, but that there are also recognisable sexual features in the sterna of individual species.

IN the February issue of the Proceedings of the Philadelphia Academy, Mr. F. W. True discusses the fossil cetacean beak from Charles County on which Cope founded the genus and species *Rhabdosteus latiradix*, together with certain other fragmentary beaks and teeth which have been assigned to the same form. In Mr. True's opinion, it is probable that while the teeth belong to the widely spread genus Schizodelphis, the type beak is generically distinct. Of the other two beaks, one apparently indicates a dolphin allied to the Amazonian Inia, while the third may be provisionally assigned to the extinct genus Priscodelphinus.

PROTECTIVE colouring in South African birds forms the subject of an article by Mr. A. Haagner in the April issue of the Journal of the South African Ornithologists' Union. One of the most remarkable instances of such protective resemblances is furnished by the rufous-cheeked nightjar. Noticing what appeared to be a strange protuberance on a bough, the author on one occasion ascended a tree to ascertain its real nature, when he was astonished to see a nightjar fly off. "The bird had been sitting lengthways on the bough, flattened up against it, and the assimilative nature of its plumage was most marked, the mottled grey-brown and rufous colouring harmonising with the bark of the tree on which the nightjar sat."

To the first number for the current year of the *Bulletin de la Classe des Sciences* of the Académie Royale de Belgique, Comte Goblet d'Alviella contributes a memoir on the excavations at Court-Saint-Etienne, in the valley of the Orne, one of the richest prehistoric cemeteries in Belgium. The remains discovered consist of articles in bronze and iron, with numerous examples of pottery. Of bronze, the most remarkable article is either a portion of a sword-belt or of a horse bridle. In some of the mortuary jars the bones of children have been discovered, pointing either to the burial of infants with their dead mothers or to a sacrifice intended to ensure the fertility of the crops. The cemetery appears to be of the well-known Hallstadt period, and the researches of Comte d'Alviella are of much interest in relation to the extension of the bronze and iron culture from the south into northern Europe.

IN the fourth part of vol. xvii. of the Proceedings of the Royal Physical Society, Edinburgh, Prof. D. C. M'Intosh discusses variation in the lobster, both in respect of the relative sizes of males and females, the relative numerical proportions of the two sexes, and in regard to the number and arrangement of the genital apertures in the male. In respect to the first point, measurements show that the female is shorter than her partner, while she also seems to be more slenderly built. The relative numbers of the two sexes cannot yet be definitely determined; it is true that more males than females are captured, but this may be due to their larger dimensions, which prevent them from escaping through the meshes of the nets, and may also lead to a smaller number being rejected as unsaleable on account of inferior size. Finally, it is demonstrated that the occurrence of additional genital apertures is by no means uncommon.

The March number of *Biometrika* contains two papers dealing with the inheritance, in two separate instances, of split hand and foot deformities in man, the so-called "lobster-claw," in which Messrs. Lewis and Embleton show that the deformity is inherited and varies in degree, although not in kind. The nature of the deformity is illustrated in a series of radiographic plates. The authors discuss the application of Mendelism to their results, and conclude that, despite the apparent segregation, the transmission is not governed by Mendelian laws. In an addendum Dr. Lewis cites cases in which hypophalangia or brachydactylia has been transmitted through normal individuals, so that the basis for the Mendelian application fails. "It may be," he urges, "and very probably is the case, that Mendelism applies to certain hereditary human deformities; but the conclusions which are being drawn, or implied, conclusions having a serious sociological aspect, are at present ahead of the facts at our disposal." In the family discussed by Mr. Pearson, there was no instance of transmission through a normal individual, but the Mendelian ratios do not fit. This case is illustrated by plates bringing out the variability of the deformity.

Among several articles of more than usual interest in the February number of the *American Naturalist*, attention may be directed to one on the law of geminate species, by Dr. D. S. Jordan, of Stanford University. Starting with the axiom that in any region the nearest representative of a given species is to be found, not in the same region or in a remote region, but in a neighbouring district separated from the first by a barrier of some kind or other, the author points out that this law rests on the fact that the minor differences separating species and races of animals are due to some form of segregation or isolation. On account of the presence of some obstacle or barrier, the members of one group are prevented from breeding with those of another minor group or with the bulk of the species, and as a result local peculiarities arise, which eventually develop into distinct races or species. On the other hand, where a number of individuals of a species are simultaneously modified in the same way by similar conditions of food or climate, they show no permanence in heredity, and should have no permanent place in taxonomy. This is exemplified by Mr. Beebe's researches into the effects of moist air in inducing dusky colours in birds, which demonstrate the impermanence of the groups or subspecies characterised by dark shades of colour developed in regions of heavy rainfall. These words, it may be added, should be well weighed by those taxonomists who name local forms characterised by the development of either unusually pale (in desert districts) or unusually dark (in moist forest regions) colouring. The fishes on the two sides of the Isthmus of Panama, which have been separated since the late Miocene or early Pliocene, afford excellent examples of geminate (twin, or representative) species, or perhaps, as we might in many cases better say, races.

In a letter to Nature of October 3, 1907, Mr. Ainley Walker asked for definite evidence bearing upon the widespread belief in many countries that the stings of bees act both protectively and as a cure for rheumatism. Dr. J. Newton Friend, North Terrace, Mildenhall, Suffolk, sends us an account of a case which has just come under his personal knowledge. Two or three years ago a country schoolmaster in Norfolk, who suffered very severely from rheumatism in the back, deliberately exposed his arms to the stings of bees, and was stung all over the arms. By the time, however, that his arms were well again, his rheumatism had completely disappeared. The gentleman who took these heroic measures is now close on fifty years of age. Dr. Friend suggests the addition of the following two questions to those given by Mr. Walker:—(1) What is the approximate age of the person supposed to have been cured? (2) In what part of the body was the rheumatism manifested, where was the person stung, and for how long was the cure effective?

Mr. T. E. D. Innes has compiled a list of Indian jungle products used as food by the natives during periods of famine, that has been issued as an appendix to the February number of the *Indian Forester*. Some of the fruits, although lacking flavour, are eaten raw, others are parched, or, as in the case of *Ficus glomerata*, *Shorea robusta*, &c., the fruits are ground into flour and baked into cakes. Several climbers yield roots that are parched or boiled, and vegetables are provided by the leaves of *Vicia hirsuta*, *Chenopodium album*, *Chlorophytum tuberosum*, and others.

The sixth number of the botanical section of the *Philippine Journal of Science*, concluding the section for the year 1907, is devoted to short notes and to the third portion of the index to Philippine botanical literature compiled by Mr. E. D. Merrill. Mr. Merrill also contributes a first addendum to his identifications of the species described in Blanco's "Flora de Filipinas," and a few additions to the species recorded for the islands. Species of Pteridanthus and Petraeovitex are new to science, and provide first records for the genus in the Philippines. Dr. E. B. Copeland is responsible for a revision of the fern genus Tectaria; many of the species are transferred from the subgroup Sagenia of the genus Nephrodium.

A note on the flora of Prince Charles Foreland, Spitsbergen, by Mr. R. N. R. Brown, published in the Transactions of the Botanical Society of Edinburgh (vol. xxiii.), refers to collections made by Dr. W. S. Bruce. The number of species totals fifty-five, or rather more than a quarter of the number recorded for the whole archipelago. The character of the flora is evident from the observation that *Saxifraga oppositifolia* is probably the commonest plant on the island and covers large areas; other species of Saxifraga are *Hirculus*, *aizoides*, *caespitosa* and *nivalis*; the species of Ranunculus and Draba are also interesting. The flora is European, and shows an entire absence of an American element.

Mr. G. H. Shull records some additions to the list of plants that conform to Mendelian principles in the February issue of the *Botanical Gazette*. The first instance cited is that of a branched specimen of the so-called "Russian" sunflower; experiments made in crossing branched and unbranched plants indicated that branching is a dominant character. Other examples were provided by plants of *Lychnis dioica* and *Verbascum Blattaria*. In the former case purple and white flowers provided reciprocal characters when according to expectation white proved to be recessive. For Verbascum, yellow colour in the flowers was found to be dominant over white, this being contrary to the experience with Polemonium and Matthiola; it is noted that in Verbascum the yellow is a sap-colour, whereas in the other two plants it is a plastid-colour.

THE new identifications, "Decades Kewenses, XVII.," that are published in the *Kew Bulletin* (No. 3) are almost entirely Malayan plants named by Sir George King, F.R.S., and Mr. J. Gamble; species are added to the genera Clerodendron, Premna, Vitex, and Petræovitex of the order Verbenaceæ. Colonel Prain forms a new genus allied to Cymaria (order Labiatæ) on the Malayan plant, *Acrymia ajugiflora*. To the same number Mr. T. W. Brown communicates an article on banana cultivation in Egypt, where the Chinese or Canary banana provides the commercially important variety. A synopsis of the New Zealand species of Rhodophyllis, by Mr. A. D. Cotton, is concerned with corrections of diagnoses by Harvey and J. Agardh; a new species is proposed, and the recently formed *Rhodophyllis chathamensis* is withdrawn. The seventh list of additions to the wild fauna and flora of the gardens includes Coleoptera, ants, scale insects, and a few plants. Mr. R. A. Rolfe contributes an article to show that there is considerable doubt as to the localities of some of Cuming's Philippine plants.

AT the meeting of the Vienna Academy of Sciences of April 2, Prof. J. Hann presented a paper entitled "The Daily Variation of Wind-force on the Mountain Peaks of South India in their Relation to the Daily Oscillation of Air-pressure." The author calculated the daily range of wind-force on the Dodabetta peak (lat. 11° 32′ N.), and at the Kodaikanal Solar Observatory (lat. 10° 40′ N.), for separate months, and found that from October to May, during the period of the north-east monsoon, the maximum wind-force occurred between 9h. and 10h. a.m., but that in June, with the advent of the south-west monsoon, it suddenly jumped backwards to 4h.–1h. a.m., while at the recurrence of the north-east monsoon in October it again jumped forward to 9h.–10h. a.m. After much laborious investigation Prof. Hann traced the cause of the shift of epoch to the double daily oscillation of the barometer, which affects the east and west wind in a different manner, as the author fully explains in the paper.

THE *Scottish Geographical Magazine* for April contains a very interesting article on the climate of the British Isles by Mr. A. Watt, secretary to the Scottish Meteorological Society. The average distribution of temperature in mid-winter and in midsummer is shown with great clearness by two maps drawn by Dr. Buchan, and reproduced from Bartholomew's "Atlas of Meteorology"; the trend of the isotherms plainly exhibits the ameliorating influence of the sea on the climate. The least difference between winter and summer is in the south-west of Ireland, where the isotherms shift by only 14°, and the greatest in the east central district of England and near London, where the isotherms shift by 25°. The author points out that the prevalence of warm south-westerly winds is the controlling factor of our climate; the Gulf Stream, to which the mildness of our winters is commonly attributed, has but little direct influence, though it may have an indirect effect by probably producing the low-pressure area off Iceland, which, together with the area of high pressure near the Azores, is the cause of our south-westerly winds. The average rainfall is exhibited by a map specially drawn by Dr. Mill from his unique collection of records. The author mentions several interesting facts tending to show that there is no evidence that our climate has changed, although it has been subject to considerable oscillations.

THE paper on electric supply prospects and changes as affected by metallic filament lamps and electric heating, by Messrs. Handcock and Dykes, read before the Institution of Electrical Engineers recently, gave rise to a very important discussion, which occupied two meetings. The metallic filament lamp has been welcomed on all sides as a solution of the problem of cheap electric lighting to compete with incandescent gas among small consumers, and there is no doubt that it has done, and will do, a great deal towards bringing the cost of lighting by electricity within the means of the smaller consumer. At the same time, central station engineers are faced with the problem that, owing to the small consumption of the metallic filament lamp, the output of the central station is very greatly reduced, thus entailing a very large increase in consumers to make up the loss incurred. Granted that this increase can be obtained, owing to the facilities that the metallic filament lamp offers, a two-fold difficulty still remains to be surmounted—(*a*) the cost of installing the wiring in small houses, and (*b*) the cost of the house-service connection. The first falls on the consumer, whether he installs it at his own cost or on the "free wiring system," the latter on the supply company. The present systems of wiring employed in this country have been made as good, as solid, and as safe as is possible, and consequently the expense is great. On the Continent the course followed is the reverse. Perhaps the system employed is not quite so secure from possible danger as is desirable, but surely some happy mean may be found. Surface wiring with a high-grade flexible would be infinitely cheaper than our present methods, and if central station engineers would agree to this or some cheaper method than that now employed, the wiring contractors would be pleased to avail themselves of the permission. At present the contractor is handicapped by the cost of the installation being too great for the prospective consumer, and consequently the central station loses also.

IN connection with the letter from Dr. J. W. Evans on the amount of helium in the earth's atmosphere which appeared in NATURE of April 9 (vol. lxxvii., p. 535), Prof. J. Hann has sent us the following table given by him in the *Meteorologische Zeitschrift* for March, 1903:—

*Percentage composition by volume of the atmosphere at different altitudes and probable temperatures.*

| Altitude ... ... | 0 km. | 10 | 20 | 50 | 100 km. |
|---|---|---|---|---|---|
| Temperature .. | 10 C. | −18°·5 | −38°·5 | −60° | −80 C. |
| Nitrogen ... ... | 78·03 | 81·20 | 84·34 | 79·17 | 0·099 |
| Oxygen ... ... | 20·99 | 18·10 | 15·19 | 7·03 | 0·0 |
| Argon ... ... ... | 0·94 | 0·56 | 0·31 | 0·03 | 0·0 |
| Carbonic acid ... | 0·03 | 0·015 | 0·006 | 0·0 | 0·0 |
| Hydrogen ... ... | 0·01 | 0·035 | 0·147 | 13·64 | 99·45 |
| Neon ... ... ... | 0·0015 | 0·002 | 0·004 | 0·0 | 0·0 |
| Helium ... ... | 0·00015 | 0·0 | 0·002 | 0·126 | 0·453 |
| Krypton ... ... | 0·00010 | 0·0 | 0·0 | 0·0 | 0·0 |
| Total pressure... | 760 mm. | 199·2 | 42·2 | 0·32 | 0·0223 |

DR. LULL'S memoir on the evolution of the elephant, referred to in NATURE of March 26 (vol. lxxvii., p. 494), appeared, not in the March number of the *American Naturalist* as stated, but in the March number of the *American Journal of Science*.

LIEUT.-COLONEL SEDGWICK writes to say that in the notice of his book, "Man and his Future," which appeared in last week's issue of NATURE (p. 5), the date of his paper on the "Form of the Atom" should have been given as 1892, and not 1902, as stated at the end of the review.

A SECOND edition of Mr. Richard Semon's "Die Mneme als erhaltendes Prinzip im Wechsel des organischen Geschehens" has been published in Leipzig by Mr.

Wilhelm Engelmann, and copies may be obtained in this country from Messrs. Williams and Norgate. The first edition was reviewed at some length in NATURE of February 8, 1906 (vol. lxxiii., p. 338), and reference may be made to that notice for a description of the characteristics of the work.

MESSRS. CHAPMAN AND HALL, LTD., have published a second edition of Dr. F. H. Getman's "Laboratory Exercises in Physical Chemistry." The first edition was reviewed in the issue of NATURE for July 28, 1904 (vol. lxx., p. 296). A chapter on thermostats has been inserted in the new edition, and the chapters treating of electromotive force, solubility, and chemical dynamics have been extended. The measurement of radio-activity has been dealt with briefly, and some other modifications made.

THE *Physical Review* for February contains an article by Mr. F. L. Bishop on the heats of dilution of certain aqueous solutions he has measured recently at the Massachusetts Institute of Technology. He finds that if concentration be represented by the ordinate, and the heat absorbed when a solution containing one gram-molecule of a dissolved salt is diluted down to the concentration in question be represented by the abscissa of a curve, the curve is a straight line for the nitrates of potassium, sodium, and barium, and approximates to two straight lines intersecting at a concentration of about 1·2 gram-molecules per litre in the case of potassium chloride. The break in this curve the author puts down to some chemical change taking place in the solution.

WE have received from the Charles Urban Trading Company, Ltd., 89–91 Wardour Street, London, W., a copy of their latest catalogue, entitled "Urbanora, the World's Educator." The list, which runs to 252 pages, deals with scientific and educational subjects treated in such a way as to be suitable for exhibition by the bioscope and microkinematograph. Films are available which depict various forms of animal life, bacteriological and other microscopic forms, and typical natural phenomena. The catalogue provides detailed information as to the subjects of science which can now be illustrated in such a way as to bring vividly before students essential facts. The actual steps in the life-histories of lowly organisms, the sequence of events in the study of the habits of plants and animals in their natural surroundings, and the reproduction of the details in typical operations to assist the teaching of operative surgery may be mentioned as examples of the way in which the kinematograph is now being utilised for educational purposes.

## OUR ASTRONOMICAL COLUMN.

THE $D_3$ (HELIUM) ABSORPTION LINE IN THE NORMAL SOLAR SPECTRUM.—An important statement by Mr. J. Evershed, concerning the presence of the dark helium, $D_3$, line in the solar spectra photographed by Mr. Nagaraja, appears in No. 396 (p. 212, May) of the *Observatory*. Readers of these columns will remember that various observers have criticised copies of Mr. Nagaraja's photographs, and have arrived at the conclusion that the dark line shown thereon is probably not the absorption line ($D_3$) of helium. But Mr. Evershed has carefully measured this dark line shown on a number of plates, and the results of his measures lead him to the belief that the line is really the helium absorption line. Micrometer measures on the actual photograph from which the copies were taken (May 4, 1907) give 5876·15 and 5876·17 as the wave-lengths of the bright line at the limb and of the dark line respectively, whilst from six determinations of each of a series of photographs obtained during 1907 Mr. Evershed obtains the mean values 5875·96 and 5875·97 respectively. The coincidence is indeed very close, and the mean value is in good accordance with the values obtained by Prof. Rowland and Prof. Hale. Mr. Evershed suggests that the prolongation of the dark line across the umbral areas, a phenomenon which proved a difficulty with the visual observers who criticised the results, may be due to the unsteadiness of the image on the spectrograph slit during a long exposure.

THE LIGHT-CURVE OF δ CEPHEI.—Between June, 1906, and September, 1907, Mr. Joel Stebbins, of the Illinois University Observatory, made a large number of observations of δ Cephei with a polarising photometer attached to the 12-inch refractor. Seventy-four observations, each consisting of ninety-six settings, were made, giving a total of 7104 settings, and every precaution was taken to make each observation perfectly independent and free from systematic errors; a sixth magnitude companion at a distance of 41″ was the only comparison star employed, but there is no evidence to show that all the variation exhibited is not due to the well-known variable. The light-curve obtained from the observations shows secondary fluctuations with maxima at 4·6 and 0·4 days. A maximum occurred on 1906, July 3·29 (=J.D. 2417395·29) and a minimum on July 1·87 (=J.D. 2417393·87), G.M.T.; the range of magnitude is shown to be 0·76 (*Astrophysical Journal*, vol. xxvii., No. 3, p. 188, April).

THE MASSES OF α CARINÆ AND α PAVONIS.—In a recent note in these columns (No. 2005, p. 520, April 2) we directed attention to a communication from Mr. Gore to the *Observatory* in which the writer, basing his conclusions on spectroscopic observations made at the Lick Observatory, showed that the binaries α Carinæ and α Pavonis should have very small masses. From a letter now published in the same journal (No. 396, p. 215, May), from Mr. H. C. Plummer, it appears that Mr. Gore's deductions were based on a slight misapprehension as to the data given in the Lick publication, and his results are therefore erroneous. Mr. Plummer's correction shows that it is quite impossible to justify the inference that the systems of these two stars are necessarily of very small mass.

THE NEW TOWER TELESCOPE OF THE MOUNT WILSON SOLAR OBSERVATORY.—No. 3, vol. xxvii., of the *Astrophysical Journal* (p. 204, April) contains an interesting description, by Prof. Hale, of the tower telescope recently erected at the Mount Wilson Observatory. We gave a brief description of the instrument proposed in our issue of February 28, 1907 (p. 424, No. 1948), and for fuller details must refer our readers to Prof. Hale's illustrated description of the actual instrument. The advantages expected to be obtained by this form of telescope mounting have been fully realised, and only one or two minor modifications, *e.g.* the reduction of the thickness (12 inches) of the mirrors employed, will have to be made. Among the illustrations reproduced in Prof. Hale's paper there is an excellent photograph of a sun-spot spectrum, on the scale of Rowland's map, which shows with remarkable clearness the "widened lines" in the *b* region.

FURTHER OBSERVATIONS OF JUPITER'S EIGHTH SATELLITE.—In No. 4246 of the *Astronomische Nachrichten* (p. 367, May 1) Sir W. H. M. Christie gives the positions of the newly discovered eighth satellite of Jupiter. The plates from which these positions were deduced were obtained on March 31 and April 3 with the 30-inch reflector, and the position of the satellite referred to three or four faint comparison stars. The positions of the latter were then determined, with reference to some thirty A.G. Catalogue stars, on a plate taken with the 13-inch astrographic refractor.

OBSERVATIONS OF PERSEIDS IN 1907.—The results of the observations of the Perseids, made by three sets of observers connected with the Kasan Observatory during the nights of August 11, 12, and 13, 1907, are given by Herr W. Milowanov in No. 4246 of the *Astronomische Nachrichten* (p. 353, May 1). The paths of 201 Perseids were recorded, and the general radiant was found to be $\alpha = 43°{\cdot}8$, $\delta = +54°{\cdot}0$ (1905·0). The real paths of some forty meteors were computed, the mean heights at the beginning and end of their visible traces being 127 km. and 86 km. respectively.

## THE EXTINCTION OF MALTA FEVER.[1]

THE subject of this evening's discourse is the extinction of Malta fever, and I propose to bring before you in this paper the various steps in the investigation of this disease which led up to the discovery of its mode of spread, and so to its prevention and extinction.

### HISTORICAL.

This fever has been studied in various ways for the last quarter of a century, but it was not until 1904 that the Government, alarmed by the great wastage in man caused by it, took the matter up seriously, and asked the Royal Society to undertake a thorough investigation of the disease. This the Royal Society agreed to do, and early in the summer of the same year sent out to Malta a small Commission for this purpose; and it is principally the result of the work of the Commission which I have the honour of bringing before you this evening.

It seems a pity that this research was not undertaken twenty years earlier, as during this time some 14,000 or 15,000 sailors and soldiers have suffered from the disease. It is to be hoped that the result of this work will bring home to the Government the great good to be gained by introducing scientific methods of research into the study of disease in the Army. This, strange as it may seem, has not yet come home to Government departments. If an application was made to the Treasury to-morrow for, say, 100*l.* for such scientific purposes, the answer would be that it was not the function of the Royal Army Medical Corps to engage in scientific research, but that their duty was to attend to the sick soldiers. This waiting until a man is sick is fatal. It ought to be our chief duty to anticipate and prevent sickness.

Before I leave the subject of the Commission, I may remark that its work went on for three years before the successful result was attained.

But now to return to Malta fever.

### DESCRIPTION OF MALTA FEVER.

At the outset it will be necessary to give a short description of this fever, in order that you may know what we are dealing with.

Malta fever is no trivial complaint, but is a severe and dangerous disease, which lasts a long time, and is accompanied by a good deal of pain. To give you an idea of the long duration of this fever, I may tell you that our soldiers remain under treatment in hospital with it on an average for 120 days, and it is by no means uncommon for a patient to suffer almost continually from it for two or even more years.

During the whole course of his illness the patient is apt to suffer from severe rheumatic pains in the joints, and neuralgia in various nerves, and this, combined with the long-continued fever, brings about a condition of extreme emaciation and weakness, from which recovery is slow.

In order to show you to what a degree of emaciation a few weeks of this fever may bring a man, I will take the liberty of throwing on the screen a photograph of a soldier who has been suffering from it for a few weeks. (Here a picture of a man extremely thin and evidently very ill was thrown on the screen.)

On admission to hospital this man was a robust and muscular soldier, and now see what a few weeks have brought him to.

### INCIDENCE OF MALTA FEVER IN THE GARRISON.

Next I would direct your attention to the number of cases of this fever which occur among our sailors and soldiers in Malta, in order to impress upon you the importance of this disease to the State. Among our soldiers, who number about 7000, there have been on an average 312 admissions to hospital every year from Malta fever alone, and among the sailors about the same number. This means that 624 soldiers and sailors have been treated in hospital 120 days each, which makes about 75,000 days of illness per annum.

To illustrate this I throw on the screen a diagram (Fig. 1).

Now I have said enough to show you that we are dealing with a severe and important form of disease.

### STUDY OF MALTA FEVER FROM THE EPIDEMIOLOGICAL POINT OF VIEW.

Before we begin the experimental investigation of this fever, it is well that we should know as much as possible about it from a general point of view. For example, in what parts of the world is it found; under what conditions of climate; whether any connection can be made out between it and the temperature or rainfall; whether age or sex render a person more liable; whether occupation or social position has any bearing on it; whether a difference in sanitary conditions has any effect, as, for example, do people living in small villages without any proper system of water supply suffer more than those living in towns supplied with pure water and a modern drainage system?

Now it is clearly impossible for me to go into all these points with the time at my disposal, but I would like to

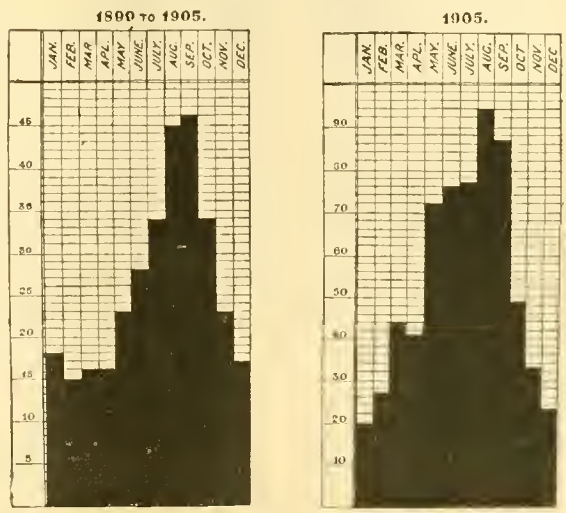


FIG. 1.—Charts of incidence in 1899–1905, and 1905.

bring before you a few facts which bear on the problem we have before us.

*Geographical Distribution.*—For example, it is interesting to know that Malta fever is not confined to Malta, but occurs in most parts of the world.

*Climatic Conditions.*—Then again in regard to the effect of climate. Malta is extremely hot and dusty in the summer, and correspondingly cold and wet in winter. But, although the number of cases of Malta fever do show an increase in summer, yet it is a disease which is prevalent all the year round, one-third as many cases occurring in the coldest and rainiest months as in the hottest and dustiest.

Another fact of importance is that if we study the occurrence of Malta fever in individual years we are struck by its irregularity, a number of cases appearing in December or February or other of the cold and rainy months.

*Social Position.*—Another curious fact in regard to this disease is that the better the social position of a person the more risk is there of catching this fever. Officers and their wives and children, living in large, airy, and clean houses, suffer more frequently than the men in their more crowded barrack-rooms. In fact, the chance of a naval or military officer taking this fever was more than three times as great as in the case of the men.

[1] Discourse delivered at the Royal Institution on Friday, January 24, by Colonel David Bruce, C.B., F.R.S.

This is shown on this diagram (Fig. 2).

*Distribution of Malta Fever among the Civil Population.*—Another important fact is the distribution of Malta fever among the civil population. Until recently it was supposed by many of us that it was restricted to the

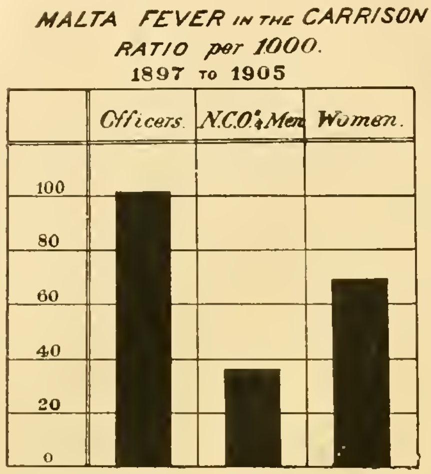


FIG. 2.—Incidence in officers, men, and women for 1897–1905.

inhabitants of the cities surrounding the Grand Harbour. This was in the days when the theory was held that the poison which causes this fever was found in the air. As the Grand Harbour at that time was in a very dirty condition, the drainage of Valletta and the three cities falling into it, there was some excuse for this belief.

Malta fever is now known to occur in every part of the island, and, in fact, the general distribution of this disease is very striking. It is not the cities round the Harbour which are struck most heavily, some of the inland towns and villages showing a much higher fever-rate.

This is illustrated by the following diagram (Fig. 3).

### SUMMARY OF EPIDEMIOLOGICAL EVIDENCE.

What, then, have we learned from the study of this fever from the general point of view?

We have found that Malta fever depends on no local conditions, as it occurs in many parts of the world. It cannot have any great dependence on climatic conditions, as it occurs in the cool and rainy months almost as frequently as in the hot, dusty, and rainless.

Poverty and insanitary surroundings do not predispose; in fact, the well-to-do classes have been shown to be more liable to take the fever than the poor. It has no connection with water supply or systems of drainage, as it breaks out as frequently in the smallest country villages as in the large cities.

What, then, is the cause of this fever?

### STUDY OF MALTA FEVER BY THE EXPERIMENTAL METHOD.

*Discovery of the Parasite.*—Let us approach this problem from the experimental side. The first step to be taken is to discover if any parasite or micro-organism is associated with this fever. To do this we examine the blood and the tissues of the various organs, both microscopically and by means of cultivation, on suitable media, to find out if anything can be seen or grown. In this way, as long ago as 1887, it was discovered by an army medical officer that a minute organism, to which the name of *Micrococcus melitensis* was given, is the cause of this disease.

*Description of the* Micrococcus melitensis.—There is not much to be said about this micro-organism, except that it is very minute, only becoming visible under a magnification of 1000 diameters. It is round or oval in shape, and non-motile. It is found in every case of Malta fever, and if injected under the skin of monkeys gives rise in them to a fever similar to that in man.

### CHARACTERISTICS OF THE *Micrococcus melitensis.*

*Behaviour outside the Body.*—Now, having found the micro-organism, it is necessary to study its characteristics.

It is found to survive outside the body for some time. For example, it can retain its vitality and virulence in a dry condition in dust or on clothing for at least two or three months. It can also live in a moist condition; in water—tap-water or sea-water—for a somewhat shorter period.

The important thing to be noted is that it does not increase outside the body; it merely survives for some time and then dies off, and, if exposed to direct sunlight, it disappears in a few hours.

Many attempts were made to discover it outside the body under natural conditions. As the generally accepted theory was that it was conveyed in air, naturally the air of fever wards or of places where cases had occurred was examined with great care. It was also looked for in the dust of suspected places and in the water of the Harbour, but with no success. It is evidently what is known as a facultative parasite, or one which depends on a host for its existence.

Thus, then, the first important step in our discovery of a means of preventing Malta fever has been taken. We now know the cause of the disease, and can look with some chance of success for the source whence man obtains it.

The next steps are to find out how this micrococcus leaves and how it gains entrance to the body.

Map of Malta and Gozo, showing the Distribution of Malta Fever in the various Towns and Villages of the two Islands

FIG. 3.—Incidence in civil population.

### HOW DOES THE *Micrococcus melitensis* LEAVE THE BODY?

In regard to the first of these, it is conceivable that it might leave the body by way of the expired air, in the saliva, in mucus from the lungs, as in consumption, in the secretion of the skin, as in scarlet fever, in the renal secretion, or by way of the intestinal tract. Or it might leave the body by way of the blood, by the agency of mosquitoes or other biting flies.

Many experiments were made along all these lines, and finally it was decided that this micro-organism leaves the body principally in the renal secretion, and in the blood taken out of the body by blood-sucking insects.

The result, therefore, of this experimental work was to give rise to the belief that the disease was either conveyed from the sick to the healthy by contact, by inhalation of infected dust, or, lastly, by the agency of mosquitoes.

### HOW DOES THE *Micrococcus melitensis* GAIN ENTRANCE TO THE BODY?

The investigation of these various modes of infection was therefore undertaken.

*By Contact.*—Let me first consider infection by contact. Experiments were made by placing monkeys, one affected by Malta fever, the other healthy, in more or less intimate contact, and it was found that if the monkeys lived together in the same cage infection did take place. If, on the other hand, the monkeys were kept in the same cage, but separated by a wire screen, so that, although they could touch each other, contamination of the healthy monkey's food by the sick monkey could not take place, then infection did not take place.

In regard to this question of conveyance by contact, there is one argument against it which has always seemed to me unanswerable, and that is that thousands of cases of Malta fever have been invalided home to England, and treated in our naval and military hospitals, without, as far as I am aware, a single case of the fever arising among the patients, orderlies, or nursing sisters.

It was therefore concluded that contact with Malta fever patients, or the handling of infected clothing or discharges, is not the mode of infection.

Then the question of infection by contaminated dust was taken up.

*By Dust contaminated by the* Micrococcus melitensis. For some time it was considered probable that this would prove to be the common method of infection. The fact that the micrococcus withstands drying for a long time, the dusty nature of Malta, and the probability that gross contamination of the surface of the soil takes place by infective discharges, rendered this view likely.

Experiments were made to put the theory to the test. Dust was artificially contaminated with micrococci and blown about a room in which monkeys were confined, or blown into their nostrils or throat. Several of these experiments were successful. It was therefore proved that dust *artificially* contamined with *Micrococcus melitensis* could give rise to the disease.

This, however, was no proof that this mode of infection occurs in Nature. The artificially-contaminated dust contained myriads of micrococci. Under natural conditions they could seldom be numerous, and the powerful Maltese sunlight would tend to kill them off rapidly. The dust blown about by the wind must also dilute the micrococci to an enormous extent, so that it is only possible to conceive of a micrococcus here and there in a vast quantity of dust. Experiments were therefore made with dust naturally contaminated, in order more closely to resemble natural conditions. Dust contaminated in this way, and also that collected from suspicious places, and blown about the cages, sprinkled on food, or injected under the skin, always gave negative results.

The conclusion was therefore again come to that conveyance of the infective germ by means of contaminated dust could only rarely, if ever, give rise to the disease.

*By Mosquitoes or other Biting Insects.*—As already mentioned, the theory had been strongly advanced that Malta fever, like yellow fever or plague, might be conveyed by blood-sucking insects. The fact that the micrococci are frequently found in the peripheral blood gave some colour to the belief. This point was therefore fully investigated, and numerous experiments made with the different species of mosquitoes found in Malta, and also with other blood-sucking insects.

The results, again, were all negative, and it was therefore decided that Malta fever is not conveyed by contact, by contaminated dust, or by mosquitoes.

What, then, could be the mode of spread?

*By Way of the Alimentary Canal.*—It had long been known that the smallest quantity of the micrococci introduced under the skin or applied to a scratch would give rise to the disease in man or monkeys, but some work by previous observers had led us to believe that infection did not take place by way of the mouth in food or drink. They had fed monkeys on milk contaminated by the micrococci, and stated that in no case had infection taken place. This observation kept the Commission at first from making feeding experiments. As infection, however, did not appear to take place by contact, by the inhalation of infected dust, or by mosquitoes, it was clearly necessary to repeat these feeding experiments.

FEEDING EXPERIMENTS.

Here is a table showing the result of some of these feeding experiments, and you see it is abundantly proved that Malta fever can be conveyed to healthy animals by way of the alimentary canal. Even a single drink of a fluid containing few micrococci almost certainly gives rise to the disease (Fig. 4).

*Malta Fever*

| Species of animal | | Mode of infection. M = M. melitensis | Probable time which elapsed before infection took place in days | Result. + Infection − No infection |
|---|---|---|---|---|
| Monkey | 99 | Feeding on potato containing M | 30 | + |
| .. | 40 | Do. do | 31 | + |
| .. | 66 | Accidental feeding .. | . | + |
| .. | 72 | Milk + M.; stomach tube | . | + |
| .. | 113 | Dust + Mediterranean fever urine Dried | | − |
| .. | 114 | Do. do | .. | − |
| .. | 119 | Dust + Mediterranean fever urine Moist | . | + |
| .. | 124 | Potato + M. from spleen | .. | + |
| .. | 125 | Do. do. | . | + |
| .. | 126 | Potato + M. from urine | .. | + |
| .. | 127 | Do. do. | .. | + |
| .. | 2 | Milk + M | .. | + |
| .. | 4 | Do. | .. | + |
| .. | 5 | Do. | .. | + |
| .. | 99 | Do. | .. | + |
| .. | 6 | Culture | .. | + |
| .. | 7 | Do. | .. | + |
| .. | 8 | Do. | .. | + |
| .. | 9 | Do. | .. | + |
| .. | 19 | Do. | 18 | + |
| .. | 19c | Do. | 32 | + |
| Kid | 9 | Milk | .. | − |
| .. | 19a | Mother's milk .. | .. | − |
| Goat | 12 | Culture from milk .. | .. | + |
| .. | 18 | Mediterranean fever urine and dust | .. | + |
| | 14 | Do. do. | . | + |
| .. | 4 | Milk + culture .. | .. | + |

FIG. 4. Feeding experiments.

From the results, then, of all these experiments it seemed most probable that the micrococcus gained an entrance to the body by way of the alimentary canal, and therefore by some infected food or drink.

FIG. 5.—Milking goat

This led to an examination of food-stuffs, and among these the milk of the goat is one of the most important.

### INFECTION BY MEANS OF GOATS' MILK.

The goat is very much in evidence in Malta, and supplies practically all the milk used. There is, I believe, one goat to every ten of the population, so that, as there are 200,000 inhabitants, there must be 20,000 goats. Flocks of them wander about the streets from morning until night, and are milked as required at the customers' doors (Fig. 5).

It must be confessed there seemed little hope that an examination of these animals would yield any result. The goats appeared perfectly healthy, and they have the reputation of being little susceptible to disease of any kind.

To put the matter to the test several goats were inoculated with the micrococcus, and the result watched. There was no rise of temperature, no sign of ill-health in any way, but in a week or two the blood was found to be capable of agglutinating the specific micro-organism.

This raised our suspicions, and a small herd of apparently healthy goats was then procured and their blood examined to see if they were all healthy. Several of them were found to react naturally to the agglutination test, and this led to the examination and the discovery of the *Micrococcus melitensis* in their blood, urine, and milk.

### Micrococci in Goats' Milk.

Some thousands of goats in Malta were then examined, and the astounding discovery was made that 50 per cent. of the goats responded to the agglutination test, and that actually 10 per cent. of them were secreting and excreting the micrococci in their milk.

Monkeys fed on milk from an affected goat, even for one day, almost invariably took the disease.

### s.s. *Joshua Nicholson*.

At this time, curiously enough, an important experiment on the drinking of goats' milk by man took place accidentally. Shortly, the story is as follows:—In 1905 the s.s. *Joshua Nicholson* shipped sixty-five goats at Malta for export to America. The milk was drunk in large quantities by the captain and the crew, with the result that practically everyone who drank the milk was struck down by Malta fever.

Sixty of the goats (five having died) on arrival in America were examined, and thirty-two found to give the agglutination reaction, while the *Micrococcus melitensis* was isolated from the milk of several of them. This epidemic of Malta fever on board the s.s. *Joshua Nicholson* therefore clinched the fact that the goats of Malta act as a reservoir of the virus of Malta fever, and that man is infected by drinking the milk of these animals.

### Epidemiological Features.

Here, then, at last was discovered a mode of infection which explains the curious features of Malta fever—the irregular seasonal prevalence, the number of cases which occur during the winter months, when there are no mosquitoes and little dust. It is true there are more cases in summer than in winter, but this may be explained by the fact that more milk is used at that time of the year for fruit, in ice-creams, &c. It also explains the fact that officers are more liable than the men, as the former consume more milk than the latter. It also explains the liability of hospital patients, milk entering so largely into a hospital dietary.

### Result of Measures Directed against the Use of Goats' Milk.

As soon as goats' milk was discovered to be the source of infection, preventive measures were begun. The result is very striking, as is shown in the charts thrown on the screen, which give the number of cases of Malta fever among the soldiers in the garrison before and after the preventive measures came into action.

Here is a chart of the incidence of Malta fever among the soldiers each month before the preventive measures were put into force (Fig. 6).

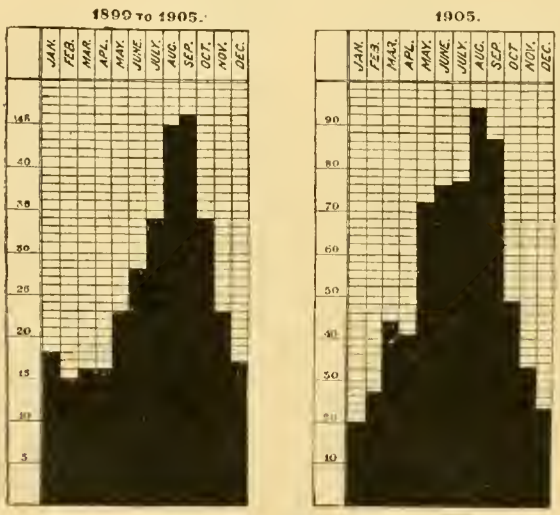


Fig. 6.—Charts of incidence among the soldiers in 1899–1905, and 1905.

And here is another showing the incidence of this fever among the soldiers and sailors in Malta since goats' milk has been banished from their dietary (Fig. 7).

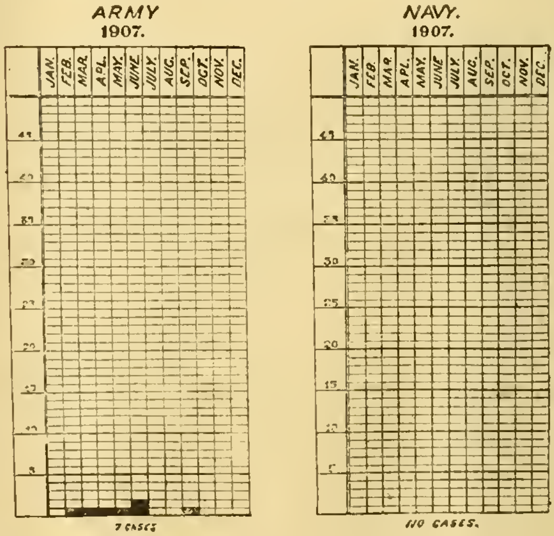


Fig. 7.—Charts of incidence among the soldiers and sailors, 1907.

With this chart, which shows the practical extinction of Malta fever, my discourse comes to a close.

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## RUSSIAN TRANSLITERATION.

THE system of transliteration from Russian generally adopted in British libraries and scientific bibliographies is that first published in Nature on February 27, 1890. It was the result of consultation by a committee of which the secretaries were Prof. Miers and the writer. This system was intended to satisfy the need for some uniform practice, and it was based on the principle that no system of transliteration from Russian would be suitable for bibliographic work unless every word may be re-transliterated into the original Russian spelling, so that it may be found in a dictionary. It was accordingly necessary that each Russian character should have one constant equivalent, and that the equivalents should be so arranged that the same combination of letters should not result from different Russian characters. It was also considered advisable to use accents as little as possible. Phonetic considerations and elegance in appearance were regarded as unimportant in comparison with the main requirements of certainty in re-transliteration.

The Imperial Academy of Sciences of St. Petersburg has recently adopted a system from the transcription of proper names into Russian. The symbols adopted by the Imperial Academy of Sciences are as follows:—

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| а | б | в | г | д | е[2]) | ё[5]) | ж | з | и[3]) | і | й | к | л | м | н | |
| a | b | v | g | d | e, je | ë | z | z | i, ji | i | j | k | l | m | n | |
| о | п | р | с | т | у | ф | х | ц | ч | ш | щ | ъ | ы | ь[4]) | ѣ[2]) | |
| o | p | r | s | t | u | f | ch | c | | š | šč | — | y | ĭ | e, jě | |
| э | ю[1]) | я[1]) | ѳ | ѵ | | | | | | | | | | | | |
| e | ju, ĭu, | ja, ĭa | f | i | | | | | | | | | | | | |

The table of Russian and Latin characters is accompanied by the following notes:—

(1) The liquid vowels я and ю beginning a syllable or preceded by ъ or ь (which, in the last case, are omitted from the transcription) are transcribed by "ja" and "ju"; if preceded by a consonant these vowels are transcribed by "ia" and "iu," if they form a syllable with the preceding consonant.

(2) The liquid vowel "e" and the vowel ѣ preceded by ь or ъ (which in this case are omitted in the transcription) are transcribed by "je" and "jě"; if preceded by a consonant these vowels are transcribed by "e" and "ě." But the liquid vowel "e" beginning a prope name is transcribed by a simple "e." Thus Egorov (pronounced Yegorov) begins with the liquid "e."

(3) The letter и preceeded by ь is transcribed by "ji" (the liquid "i").

(4) The letter ь at the end of a word or before a consonant is transcribed by "ĭ."

(5) The letter "e," when it is pronounced "jo," is represented, as in Russian, by "ë," but only when the author writes his name in that way.

(6) The names of foreign authors who have written in Russian are re-transcribed according to this system when the original orthography of these names is unknown; when it is known, the transcription of the Russian form of the name can be given in a note.

The British system also proposed to use the original form of any Russianised proper name in preference to re-transliterating them.

The Russian Academy's system does not attempt to secure the precision in re-transliteration which was the main object of the British system; for the letter "f" stands for either ѳ or ф; "u" stands for "y" or occurs in combination with "j" (which is itself the transliteration of й) for ю; "i" may be the transliteration of any one of four letters, и, i, ь, or ѵ, as well as in combination with "u" and "a" from ю or я. The English "e" is the equivalent of either "e," ѣ, or э. Five Russian letters have alternative transliterations. Phonetically, the Russian system has some advantage over the British, although in this respect it is in some ways less satisfactory. The Russian system, however, is proposed only for proper names, for which a less rigid system is perhaps necessary than for general scientific and bibliographic work.

J. W. Gregory.

## DYEING QUALITIES OF NATURAL AND SYNTHETIC INDIGO.

The annual report, written by Mr. Cyril Bergtheil, of the Indigo Research Station of the Bihar Planters' Association for the year 1907–8 has just been issued; it contains an interesting statement with regard to the value of "synthetic" indigo as a dye-stuff compared with natural indigo. From last year's experiments (see Nature, vol. lxxv., p. 614) it was concluded that "synthetic" indigo gives poorer results under practical conditions than those obtained with the natural dye, the latter imparting a richness of shade or "bloom" which was unobtainable with the synthetic material. It has since been ascertained that the synthetic indigo supplied for the tests was "brand E" of the Badische Anilin- und Soda-Fabrik, which contains some 25 per cent. of lime; the presence of this high proportion of alkali would of itself account for the bad results obtained in the hydrosulphite vat. Experiments will now be made using the material which the Badische company itself recommends for the hydrosulphite vat.

The rest of the report deals with the results obtained in experiments made to ascertain the best conditions to be observed during the growth of the indigo plant, and in the extraction of the dye subsequently. Good results have been obtained by the use of sulphuric acid as a means of facilitating the germination of the seed of the Java plant, as recommended in a previous report (Nature, vol. lxxv., p. 497), but care must be observed in ensuring that the acid used is of correct strength. A number of interesting experiments made to ascertain the effect of manuring on the production of indican in the plant are also reported. It would appear that the proportion of indican in the plant is independent of, or is actually decreased by, manurial treatment; in fact, the production of indican appears to be a starvation phenomenon, the proportion of the dye being increased by the absence of moisture and by adverse climatic conditions. On the other hand, the fertility of the land must not be allowed to drop too much, otherwise the growth of the plant as a whole is interfered with, and the return of the dye per acre is affected. New fungoid diseases, and an insect pest producing ravages on indigo plants, are also dealt with in the report.

## MAY METEORS

May, like June, cannot be said to be prolific of meteoric showers or to offer special inducements to observers. There are, of course, the May Aquarids, due during the first week of the month in the morning hours. There is also a pretty rich shower of Coronids between about May 11 and 18, but they are not often seen in marked prominence; and I believe there is a special shower at the close of May from the N.W. region of Pegasus, at about $334° + 28°$, which deserves more attention. I found the position of this radiant on reducing a number of meteors recorded by the Italian Meteoric Association in 1870, and very satisfactorily confirmed the showers in 1886 May 29 to June 4, the exact positions being $330° + 28°$ and $333° + 27°$ respectively.

There is a well-marked radiant of slow meteors from this point in July and August, but it has been seldom noticed at the close of May and early days of June. This year moonlight will not interfere with observation, and it would be interesting to watch the eastern sky in the mornings of May 29 to June 4 for the purpose of further investigating these $\eta$ Pegasids. They are of the Perseid type, being swift and streaking meteors, and I think the stream may prove of some importance among the spring showers, though very little is known of it.

Any observations conducted for the purpose of re-detecting the system may also be found useful in giving us a fuller insight into the other meteoric displays of the same period.

W. F. Denning.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Twenty students matriculated this term, bringing the total number for the year up to 1162. This is an advance of seventy-nine on the numbers for last year, and of ninety-seven on the numbers for 1906 to the present date. The increase in the number of advanced students over that of last year is *ten*.

It is proposed to confer the degree of Master of Arts, *honoris causa*, upon Mr. A. Henry, reader in forestry.

Mr. F. Darwin, F.R.S., has been nominated the representative of the University at a meeting convened by the Linnean Society of London to be held in July in celebration of the fiftieth anniversary of the reading of the joint essay by Charles Darwin and Alfred Russel Wallace "On the Tendency of Species to form Varieties; and on the Perpetuation of Varieties and Species by Natural Means of Selection."

The general board has reported on the proposed readership in metallurgy which the University will be enabled to establish by the munificence of the Goldsmiths' Company, which has presented 10,000*l.* for the purpose of founding and endowing a readership in metallurgy. The board is of opinion that the generous offer of the Goldsmiths' Company should be accepted, that a readership in metallurgy should be established, that the readership should be associated with the name of the company, and that among the principal duties of the reader should be that of research and other work in the precious metals and of instruction in the theory and practice of assaying. The board is of opinion, further, that the stipend attached to the readership should be 300*l.* a year, or such larger or smaller sum as the capital may produce. The board has consulted the professor of chemistry, and finds he is of opinion that there is suitable and sufficient accommodation in the present chemical laboratory to enable the reader to carry out the special duties of his office, but if the metallurgy of the commoner metals is to be studied accommodation will have to be provided on another site more suitable for the purpose.

LONDON.—Sir Arthur Rücker, principal of the University, was unfortunately absent through illness on Presentation Day, May 6, and was therefore unable to deliver his valedictory address. The principal's report, read by the secretary to the Senate, showed continued progress. Matriculation candidates were 7356 in 1907–8, compared with 7112 in 1906–7 and 7036 in 1905–6; of the 7356, however, only 3277 were admitted to the University. Eighty-five graduates of other universities and others similarly qualified have taken advantage of Statutes 113 and 129, and are now studying in London as internal students with the view of taking a higher degree of the University of London. Gifts amounting to 24,667*l.* had been received by the University during the past year. In concluding his report, the principal said:—"For three-quarters of a century all efforts for the establishment of university education in London were spasmodic, disconnected, and sometimes even avowedly antagonistic. Eight years of an attempt to substitute for this condition of chaos a common policy and such common government as may be compatible with the free play of individual effort have justified those who supported and carried the great reform which took effect in the autumn of 1900." The presentees included eleven Doctors of Science (eight in science, one in engineering, and two in economics), thirty-three Doctors of Medicine and eight Masters of Surgery, one Doctor of Literature, and one Doctor of Divinity.

The University exhibit at the Franco-British Exhibition promises to be very interesting and comprehensive. It will consist mainly of photographs, publications, and charts. An exhibit representing medical education in London, and another illustrating the social and athletic life of the students, have been specially organised. One of the most valuable exhibits is a collection of publications by teachers of the University and their students in the year 1907; a special catalogue of this collection is to be published. The University will publish a special handbook containing a catalogue of the University exhibit. The medical schools have prepared a large and fully illustrated handbook on medical education in London, and the students' representative council has published a students' handbook dealing especially with the social and athletic life of the student. Copies of all these publications will be available for visitors to the exhibition.

Admission is free to the following lectures addressed to advanced students of the University and others interested in the subject of the lectures:—Eight Mercers' Company lectures on "Recent Advances in Physiology," Prof. E. H. Starling, F.R.S.; four lectures (under the Chadwick benefaction) on "The Engineering Aspect of Recent Advances in connection with Sewering," W. D. Scott-Moncrieff; eight lectures on "Cholesterol and Lecithin: from the Chemical and Physiological Standpoints," J. A. Gardner; three lectures on "The Early Development of Mammalia," Prof. J. P. Hill; eight lectures on "Fossil Ferns and Allied Seed Plants," Dr. D. H. Scott, F.R.S.; three lectures on "The Thames and its Tributaries," Prof. H. G. Seeley, F.R.S.; and four lectures on "Recent Advances in the Determination of Minerals by Optical Methods," Dr. J. W. Evans. Particulars as to the lectures can be obtained from the academic registrar of the University.

OXFORD.—The following is the text of the speech delivered by Prof. Love in presenting Prof. W. James for the degree of D.Sc., *honoris causa*, on May 12:—

Adest Willelmus James, in Academia Harvardensi Professor emeritus, novi rerum ordinis in Psychologia inventor. Qui vir, quo magis eam scientiam promoveret quæ mentis humanæ agitationes, cogitationis memoriæque rationem, sentiendi, percipiendi modos complectitur, nulla fere disciplina non institutus est. Neque enim solum acuto, ut philosophus, ingenio, sed usu et scientia, ut medicus, peritia etiam experimentis parta, ut physiologus, præstabat. Accessit, quod caput est, mira quædam divinandi facultas. Quæ renuntiat suis oculis assecutus est, vir non legendo sed intuendo doctus: idem admirabili dicendi genere inventa explicat. Mox a psychologia ad philosophiam conversus fecit ut hæc studia in omni orbis terrarum parte revivescerent. His quidem diebus apud nos de philosophia luculenter contionatus magno iuniorum seniorumque conventu Academiam nostram maxime delectavit.

THE Court of Glasgow University has decided to establish a lectureship in geography at the University.

THE King has consented to visit Leeds in July, accompanied by the Queen, for the purpose of opening the new university buildings.

VISCOUNT MORLEY OF BLACKBURN has been elected Chancellor of the University of Manchester in succession to the late Duke of Devonshire.

ARMSTRONG COLLEGE, Newcastle, has accepted with thanks an offer from Lord Barnard to place the sum of 1000*l.* in trust for the benefit of the agriculture department of the college.

THE public bequests announced under the will of the late Mr. T. Webb include:—University College, London, 5000*l.*, to be used and applied, so far as is practicable, for the purposes of physical research; University College of South Wales and Monmouthshire, 5000*l.*, also to be applied, so far as is practicable, for the purposes of physical research.

AT a meeting of the Bristol City Council, held on May 5, a resolution was passed in favour of the proposal "to establish a university for Bristol and the west of England, and agreeing to give financial assistance to such university in the event of a charter for its establishment being obtained, provided arrangements as to the constitution of the university satisfactory to the council have been made."

IN the House of Lords on Tuesday, Lord Stanley of Alderley moved the second reading of a Bill the main object of which was to make thirteen the minimum age at which a child can be exempted from the obligation to attend school. The second reading was rejected, not because any argument against the Bill could be put forward from the point of the physical and mental welfare of the nation, but because, to use the words of Lord Tweedmouth, "a sudden change in the law would cause a very considerable amount of inconvenience, especially to the agricultural interest, to the cotton interest, and to some extent to the woollen interest." So the healthy development of the body and mind of the child has to be sacrificed to these various interests. Meanwhile, the Education Bill for Scotland, read a second time in the House of Commons on May 5, makes fourteen the normal age of leaving the primary school. Evidently, we have to look to the north for advance in educational standards.

PROF. AINSWORTH DAVIS has been appointed principal of the Royal Agricultural College, Cirencester. The college was founded in 1845, and has hitherto been conducted without the least aid from Government or local authorities. It has been decided, however, to re-constitute the college, making it a public institution with a representative governing body, in association with the county councils of Gloucestershire and the adjoining counties. In addition to providing courses for pupils proposing to become farmers or manage estates, it is proposed to hold vacation courses for village schoolmasters desiring to become qualified to teach rural subjects. Forty acres of land are attached to the college, and, in addition, the students have access to a farm, arable and pasture, of more than 450 acres. Great attention is directed to forestry, and the professor and students have the advantage of a forest nursery located in Earl Bathurst's park, a portion of which he placed at the disposal of the college for this purpose.

THE Board of Education has published (Cd. 4037) the Regulations for English Secondary Schools for the year beginning August 1 next. The regulations are in main substance the same as those of last year. Owing to difficulties which have arisen during the past year in the interpretation of the regulations referring to the provision of free places in secondary schools, these rules have been further defined. It is made clear that boys and girls applying for such free places may be required to pass an entrance test of attainments and proficiency, having due regard to the age of the applicants, the subjects in which they have been receiving instruction, and the standard of attainments and proficiency required for the admission of fee-paying pupils. Pupils who enter the school as bursars or pupil teachers must not be counted in estimating the number of free places provided. In examinations held for the selection of boys and girls to occupy free places, importance is to be attached to the report of the candidate's own teachers, and the masters or mistresses of the secondary school are to be associated with teachers familiar with elementary-school conditions in conducting the examination. The regulations make provision, too, for greater elasticity in the way of adapting the instruction to the requirements of the pupil, though precautions are taken to see that this privilege is used with proper moderation. To meet the difficulty of providing secondary education in rural areas and less populous urban or semi-urban districts, the Board is prepared next year to recognise secondary schools with fifteen instead of sixteen as the normal leaving age, but this concession is only made where a consideration of local circumstances shows that it will be of distinct educational advantage to the district, and that a longer school-life is not under actual conditions possible.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society,** June 27, 1907.—"On the Polymorphic Changes of Ammonium Nitrate." By U. **Behn.** Communicated by Prof. A. Schuster, F.R.S.

The main results of the research may be summarised as follows:—

(*a*) From the dilatometric and crystallographic work no definite information is forthcoming which affords any precise proof as to a difference in properties of the two tetragonal modifications of ammonium nitrate.

(*b*) The argument derived from the investigation of the thermal properties tells, so far as it goes, against the identity of the two tetragonal modifications, but it cannot be considered as decisive.

January 30, 1908.—"The Refractive Index and Dispersion of Light in Argon and Helium." By W. **Burton.** Communicated by Prof. J. J. Thomson, F.R.S.

The initial object of this research was to find the dispersion of light in the monatomic gases argon and helium, but as it was necessary to know the absolute value of the refractive index with considerable accuracy, determinations of the refractive index were made.

The results for argon and helium are tabulated below, and, for comparison, Mascart's values for hydrogen are also given.

Refractive index, reduced to 0° C. and 760 mm. pressure for $D_1$ line.

| | |
|---|---|
| Argon ... ... ... ... | 1·0002837 |
| Helium ... ... ... ... | 1·00003500 |
| Hydrogen (Mascart) ... ... | 1·0001387 |

Dispersion:—In equation

$$n-1=a\left(1+\frac{b}{\lambda^2}\right),\ \text{or}\ n=A+\frac{B}{\lambda^2},$$

| | $b$ | $a$ | A | B |
|---|---|---|---|---|
| Argon ... | $5{\cdot}6\times10^{-11}$ | 0·0002792 | 1·0002792 | $1{\cdot}6\times10^{-15}$ |
| Helium... | $2{\cdot}2\times10^{-11}$ | 0·00003478 | 1·00003478 | $7{\cdot}5\times10^{-16}$ |
| Hydrogen (Mascart) | $4{\cdot}3\times10^{-11}$ | 0·0001376 | 1·0001376 | $5{\cdot}9\times10^{-15}$ |

It may be noted that the values of $a$ $b$ for these substances are approximately in the ratio 3 : 1 : 2.

February 13.—"The Effect of Hydrogen on the Discharge of Negative Electricity from Hot Platinum." By Prof. H. A. **Wilson,** F.R.S.

The view taken in this paper is that the effect of the hydrogen on the leak is due to its presence in the surface layer of the platinum. To explain this it is supposed that the hydrogen atoms in the layer are positively charged, so that they diminish the charge per unit area in the electrical double layer covering the surface of the platinum. The hydrogen appears to dissolve in the platinum at first, but at high pressures in time forms a stable combination with the platinum, having a very small dissociation pressure. Before this compound has been formed, the leak is proportional to a power of the pressure of the hydrogen.

February 20.—"On the Dispersion of Gaseous Mercury, Sulphur, Phosphorus, and Helium." By C. **Cuthbertson** and E. Parr **Metcalfe.** Communicated by Prof. F. T. Trouton, F.R.S.

In continuation of previous work on the refractive indices of certain elements in the gaseous state, the authors have measured the dispersion of the elements named above within the limits of the visible spectrum.

The results obtained may be summarised as follows:—

$$\text{Mercury} \quad \ldots \quad \ldots \quad \mu-1=0{\cdot}001755\left(1+\frac{2{\cdot}265}{\lambda^2 10^{10}}\right).$$

$$\text{Sulphur} \quad \ldots \quad \ldots \quad \mu-1=0{\cdot}001046\left(1+\frac{2{\cdot}125}{\lambda^2 10^{10}}\right).$$

$$\text{Phosphorus} \ldots \quad \ldots \quad \mu-1=0{\cdot}001162\left(1+\frac{1{\cdot}53}{\lambda^2 10^{10}}\right).$$

$$\text{Helium} \quad \ldots \quad \ldots \quad \mu-1=0{\cdot}0000347\left(1+\frac{2{\cdot}4}{\lambda^2 10^{11}}\right).$$

The dispersion of mercury is about four times that of air.

The index of sulphur for infinite waves is, within 2 per cent., four times that of oxygen. Its dispersion is, not so exactly, four times that of oxygen.

The index of phosphorus, for infinite waves, is exactly four times that of nitrogen. Its dispersion is almost exactly twice that of nitrogen.

The index of helium is, within 1·6 per cent., one-eighth of the best existing value for the index of argon. Its dispersion is about three-sevenths that of air.

March 5.—"On the Electrical Resistance of Moving Matter." By Prof. F. T. **Trouton,** F.R.S., and A. O. **Rankine.**

The question of relative motion between the earth and the neighbouring ether has been under discussion for many years. It has, from time to time, been the subject of important investigations, but these have all resulted negatively. The experiment described in the present paper is not different from them in this respect, yielding, as it does, no definite information on the main point. Indirectly, the aim was to measure the direction and magnitude of ether-drift, the actual method having been to attempt to demonstrate the existence of the Fitzgerald-Lorentz shrinkage, which has been supposed to mask the effect in the direct experiments of Michelson and Morley, and of Trouton and Noble.

The results lead the authors to conclude:—

(1) The total electrical resistance of a wire is not altered by an amount exceeding $5\times10^{-10}$ of the whole amount by any change of its position relative to its motion through space.

(2) On the assumption that the Fitzgerald-Lorentz shrinkage is a real effect, the specific resistance of a material is dependent upon the direction of flow of the current, being greater to a current flowing parallel to the velocity of the material through space than to a current in a perpendicular direction. The magnitude of this change of specific resistance is shown by the experiments to be certainly within 2 per cent. of being sufficient to compensate the change of length.

March 12.—"Bacteria as Agents in the Oxidation of Amorphous Carbon." By Prof. M. C. **Potter.** Communicated by Prof. J. B. Farmer, F.R.S.

Under conditions of exposure to the air, a slow oxidation of amorphous carbon takes place through the agency of bacteria. This has been conclusively established by experiments upon such carbonaceous substances as charcoal, lamp-black, coal, and peat.

When these substances are subjected to bacterial action carbonic acid is given off, as estimated volumetrically by absorption in baryta solution and titration with standard oxalic and hydrochloric acids.

The amount of $CO_2$ given off increases in proportion to the rise of temperature, and ceases to be evolved at a supra-vital temperature. There is no evolution of $CO_2$ under perfectly dry conditions such as preclude the possibility of bacterial life.

A distinct rise of temperature occurs through the action of bacteria. The heat generated was determined by measurement, with a galvanometer, of the electromotive force produced by the difference of temperature between two thermo-elements, one placed in a sterile and the other in an inoculated flask.

The evolution of $CO_2$ and the accompanying rise of temperature does not take place when carbonaceous substances are preserved from the intrusion of micro-organisms.

The heat generated by microbial activity is an influence to be taken into account in connection with the oxidation and spontaneous combustion of coal; it may be a dangerous motive force acting upon explosive gases.

The oxidising action of bacteria must be largely responsible for the disintegration of coal and the high percentage of depreciation which it undergoes in store.

Coal and peat, like other organic matter, are liable to decomposition as soon as conditions are presented suitable for the life of aërobic organisms. The carbon is then once more liberated in the form of $CO_2$ to play its *rôle* in the life-cycle. It is thus conceivable that the vast supplies of carbon locked up in the world's coalfields may become available for plant nutrition without the intervention of direct combustion.

"The Origin and Destiny of Cholesterol in the Animal Organism," parts i. and ii. By C. **Dorée** and J. A. **Gardner.** Communicated by Dr. A. D. Waller, F.R.S.

These two papers throw some further light on the interesting question of the part played by cholesterol in the economy. The authors made, first, a very thorough and careful examination of the excretion of cholesterol by the dog. The animal was fed for periods varying between fourteen and thirty days on diets the cholesterol content of which varied greatly. The output of cholesterol in the fæces was in every case found to be a function of the food taken. Thus in seventeen days on horseflesh one gram of cholesterol was recovered, in thirty-one days on oatmeal and water 0·1 gram only. On a diet of raw brain, which is rich in cholesterol, a very interesting result was observed. In fourteen days the output amounted to 17 grams, and it consisted entirely of coprosterol, the dihydrocholesterol normally present in human fæces. In every experiment the cholesterol actually found was very much less than the quantity that should have been poured into the intestine with the bile.

In the excrement of grass-fed animals the main cholesterol product is the so-called hippocoprosterol, which is shown to be an alcohol, $C_{27}H_{54}O$, melting at 79° C. But far from being, as previously supposed, reduced from cholesterol in the intestine of the animal, it is merely a constituent of the grass taken as food. This was finally and clearly proved by feeding a rabbit on grass from which the chortosterol (as the authors propose to re-name it) had been removed by extraction with ether. The body could no longer be obtained from the fæces. No trace of cholesterol was found in the excrement of the herbivora examined, and it thus appears probable that the cholesterol of their bile is actually absorbed in the intestine—a point at present under investigation.

April 2.—"The Antagonistic Action of Calcium upon the Inhibitory Effect of Magnesium." By S. J. **Meltzer** and J. **Auer.** Communicated by Prof. E. H. Starling, F.R.S.

In a series of recent studies which the authors have carried out upon the relations of the effects of calcium to magnesium, many facts came to light which demonstrate unmistakably that calcium is the most available agent to neutralise inhibitory effects of magnesium. The following experiment is an instance:—

By subcutaneous injections of a magnesium salt (for instance, Epsom salt—about 7 c.c. of a 25 per cent. solution per kilogram), rabbits are brought to a profound state of anæsthesia and paralysis. The slow and shallow respirations indicate the approaching danger. Now 6 c.c. or 8 c.c. of an M/6 or an M/8 solution of a calcium salt are given through the ear vein. Within a few seconds the respiration becomes quicker and deeper, and within one minute the animal turns over, sits up, and appears normal.

Here calcium not only did not add an inhibitory effect, but completely neutralised the profound inhibitory effect of magnesium. The companionship of calcium and magnesium within the body means, at least in many instances, not a concerted action of similar effects, but rather a resultant effect of antagonistic actions.

**Royal Microscopical Society,** April 15.—Mr. Conrad Beck, vice-president, in the chair.—Dendritic growths of oxide of copper on paper: J. **Strachan.** The results verified previous investigations, showing that these dendrites originated in minute particles of copper, their branching being due to the direction of the fibres in the paper.—Nature's protection of insect life: F. **Enock.** The slides were taken by the Sanger-Shepherd three-colour process, and Mr. Enock described the method he employed in their production.

**Geological Society,** April 15.—Dr. J. J. Harris Teall, F.R.S., vice-president, in the chair.—The geological structure of the St. David's area (Pembrokeshire): J. F. N. **Green.** The Cambrian rocks were first traced and found to be faulted greatly. The faults have been followed into the volcanic tuffs (Pebidian), and the succession determined and pieced together. In this way the Pebidian has been subdivided into fourteen horizons, with a total visible thickness of more than 3000 feet. The subdivisions are classified into four series, the lower two of which are composed of trachytic pebbles in a chloritic matrix, and separated by a schistose quartz-felspar-porphyry sill. The third series is composed of rhyolite and hälleflinta fragments in a silicified matrix, and the topmost of highly sheared schistose beds. The tuffs appear to be mainly detrital. An unconformity between the Pebidian and the Cambrian is demonstrated. The schistose sill has been traced into the porphyritic margin of the St. David's granophyre (Dimetian), and it is inferred that the granophyre is a laccolitic intrusion in the Pebidian. The boundaries between the granophyre and the Cambrian are prolongations of faults proved in the latter, except at one point in the well-known Porthclais district. A trench opened here exposed basal Cambrian rocks resting upon a denuded surface of the granophyre, which is therefore of pre-Cambrian, but of post-Pebidian age. The relationships of the basic igneous rocks west of St. David's are discussed, and they are all described as post-Cambrian intrusions.—Notes on the geology of Burma: L. V. **Dalton.** The results are given of geological expeditions in the Irawadi Valley, carried out between 1904 and 1906, and present knowledge of the geology of Burma in general and of the Tertiary system in particular is summarised.

**Zoological Society,** April 28.—Dr. Henry Woodward, F.R.S., vice-president, in the chair.—A revision of the sharks of the family Orectolobidæ: C. Tate **Regan.** Twenty-one species were described, and were referred to eight genera. Attention was directed to the great differences in form, coloration, &c., among the members of the family, corresponding to differences in habits and environment.—Identification of an oligochæte worm obtained in considerable numbers from a well near Cambridge, England: F. E. **Beddard.** The author described the worm as a new species of the genus Phreatothrix, the only other species of which had been described thirty years ago from the underground waters of Prague.—The amphipod genus Trischizostoma: Mrs. E. W. **Sexton.** The memoir was based on a rich material obtained by the steamer of the Marine Biological Association in the Bay of Biscay, and by the steamer of the Irish Department of Agriculture off the west coast of Ireland.—Certain errors respecting George the Fourth's giraffe: H. **Scherren.** The author adduced evidence to show that the time the animal lived at Windsor had been much understated, and added details as to its life in confinement, the presentation of the skin and skeleton to the museum of the society, and the notes made by R. B. Davis while painting a picture of the animal at Windsor.—Observations on the breeding-habits of a cichlid fish (*Tilapia nilotica*) made in the course of a visit last year to Lake Qurun in the Fayûm province of Egypt: C. L. **Boulenger.**—A revision of the Oriental pelobatid batrachians (genus Megalophrys): G. A. **Boulenger.**

**Challenger Society**, April 29.—Sir John Murray in the chair.—A series of hydrographical sections, illustrating the work of Dr. R. N. Wolfenden's yacht *Silver Belle* in 1905 off south-west Ireland and down to Gibraltar: Dr. H. N. **Dickson.** The observations allowed the extension into the Atlantic of the Gibraltar under-current of high temperature and salinity to be carefully re-studied; its effects were observed to reach to 700 or 800 fathoms, where it spreads out as a flat sheet, the high salinity of which gives it a specific gravity equal to that of the colder, fresher Atlantic water. The northward range of this water varies from year to year, and must be taken into account by the International Commission for the Study of the North Sea as a third factor in tracing the sources of Channel and North Sea water.—Practical methods for the collection and investigation of water samples and temperatures: D. J. **Matthews.**

### Dublin.

**Royal Dublin Society**, March 24.—Prof. Sydney Young, F.R.S., in the chair.—Reports upon the Irish peat industries (part ii.): Prof. Hugh **Ryan.** The author begins with a description of the methods employed in Ireland for the preparation of peat fuel, and then reviews the attempts which have been made at various times to convert peat into a fuel of greater density than that ordinarily obtained by the Irish farmer. A recommendation is made for the establishing of suitable industries, such as that of glass-manufacture, at carefully selected points of the peat districts having machine-formed turf and peat-moss litter factories in connection with them. The economic importance of "generator gas" and of "mixed power gas" from peat is also considered in the paper, which concludes with a description of the "Woltereck process," employed at Carnlough, co. Antrim, for the preparation of ammonia from peat.

April 14.—Prof. Sydney Young in the chair.—The eruption of Vesuvius, 1906: Dr. H. J. **Johnston Lavis.** The author describes, from information collated and from personal observations a few days after the great outburst, the succession of events at Vesuvius in April, 1906. He points out that these events, and the manifestations since 1872, may be referred to the usual local alteration of "Strombolian" and paroxysmic "Vesuvian" stages of activity. He attributes the great outbursts of volcanic dust, accompanying the crater-forming stage, to the falling in of loose material from the crumbling cone when the lava-column has been drained down to a low level, and to its second ejection by the upbursting steam. In the cone-building stage, on the other hand, the lava-cake on the top of the magma-column, now high up in the vent, is exploded in the form of "essential" scoriæ. The courses of the lava-flows of 1906 are traced out, and their petrography and mineralogy are described. The paper was illustrated by a number of original photographs, including panoramic views showing the ash-deposits and the truncation of the cone.—The radium contents of the rocks of the St. Gothard Tunnel (preliminary note): Prof. J. **Joly.** Estimates of the radium in some typical rocks through which the tunnel was carried show a distribution of radium in accordance with the elevation of temperature which Stapff observed at the northern end of the tunnel and the lesser gradients met with at the south end. So far as the investigation has gone, the average radium content of the rocks of the central and southern sections of the tunnel is considerably below that observed by the author in the case of the Simplon rocks.

**Royal Irish Academy**, April 13.—Dr. F. A. Tarleton, president, in the chair.—Malignant tumours in birds, with observations on certain changes in the blood: Prof. A. E. **Mettam.** The tumours were round cell sarcomata, seen in the domestic fowl (three cases), and a true carcinoma found replacing the left lung in a thrush (*T. musicus*). Interesting changes were observed in the red blood corpuscles of the thrush. Numerous corpuscles showed profound nuclear degeneration; the nuclei were swollen, approaching the circular in outline, the chromatin network being more distinct. The protoplasm of the corpuscles showed polychromatophilia, and eventually entered into solution. The nuclear substance, now having lost its structure, remains as an irregular lump, staining especially with the acid dyes.—Spirochætes in infective sarcomata of dogs: Prof. A. E. **Mettam.** The author describes certain spirochætes, fusiform and bacillary bodies in smears obtained from the infective sarcomata developed on and in the genital organs of dogs. The number of undulations in the spirochæte is generally five, the length of the organism about 17 $\mu$. The bacillary bodies are long or short, stiff, or, when long and attenuated, slightly undulating. They show metachromatic granules, and may have some relation to the spirochæte which they invariably accompany.—The mouth-parts of some Blattidæ, including a detailed account of the mandibles and maxillæ of *Periplaneta australasiae*, compared with those of other species of the family: J. **Mangan.** The author shows the presence of a distinct lacinia mobilis in the mandible, and gives a full description of the musculature, both of mandibles and maxillæ. He discusses the various views that have been proposed as to the homologies of the parts of a maxilla, and controverts Verhoeff's recent suggestion that the hexapodan maxillæ are primitively posterior to the labium.

April 27.—Dr. F. A. Tarleton, president, in the chair.—A new Devonian isopod from Kiltorcan, co. Kilkenny: Prof. G. H. **Carpenter** and I. **Swain.** The fossil, named *Oxyuropoda ligioides*, bears a general resemblance to an oniscoid. The first thoracic segment is closely united with the head, and appears to carry chelate limbs; the uropods are lateral, elongate, acuminate, and unjointed. This forms an interesting addition to the few Palæozoic isopods hitherto known.

### Paris.

**Academy of Sciences**, May 4.—M. H. Becquerel in the chair.—Formulæ relating to the minima of classes of binary, positive quadratic forms: G. **Humbert.**—The discovery of the law of falling bodies: Pierre **Duhem.** The fact that the velocity of a freely falling body increased in velocity proportionally to the time of fall was well known to Leonardo da Vinci, but it is not stated in his manuscripts whether this was his own discovery, or whether he had derived it from earlier sources. A clear definition of uniformly varying motion was given by Albert de Saxe in 1351, but his view as to the law of a falling body appears to have been erroneous, and it would seem probable that the real law was discovered by da Vinci.—Canonical hyperelliptic functions of the second species: Z. **Krygowski.**—The application of the laws of similitude to the propagation of deflagrations: M. **Jouguet.**—The comparison of continuous current series and shunt dynamos from the point of view of rapidity of starting: Paul **Girault.** Series winding gives the more rapid starting.—A new radiographic method capable of deciding whether a supposed still-born child has really lived or not: Charles **Vaillant.** With infants which have not lived no organ is visible on the radiograph. With infants which have taken a few breaths the stomach alone is visible. When the stomach is more transparent and the intestine becomes visible, the child has lived from one to fourteen hours. In the case of infants who have lived some days without food, the abdominal organs, the lungs, and the liver show on the radiograph. With infants fed during several days all the organs are clearer, and the mass of gas in the intestine allows of a much clearer image of the intestinal mass.—The ultra-violet spark spectrum of dysprosium, and on some remarkable magnetic properties of this element: G. **Urbain.** A catalogue of the spectrum lines of this element for wave-lengths between 2872 and 4221 is given. The coefficient of magnetisation of dysprosium oxide was determined by means of the Curie and Chéneveau magnetic balance; the oxide was found to be about 12·8 times more magnetic than the oxide of iron, $Fe_2O_3$.—The removal of certain soluble substances from solution by precipitates: Paul **Frion**. It has been shown by Jean Perrin that contact electrification plays an important part in certain physicochemical phenomena, and he has applied this to the case of colloidal solutions. The author shows that similar considerations are capable of explaining the removal of soluble salts from solutions by precipitates.—The variation of the electromotive force of liquid chains by the polarisation of interposed diaphragms: Pierre **Girard**. The modifications in the voltage of liquid couples caused by diaphragms or membranes do not appear to be due to the variation of the mobility of the ions in the interposed medium. They appear rather to be due to phenomena of contact electrification.—The synthesis of ammonia and hydrocyanic acid: Herman C. **Woltereck**. By the passage of air through a Dowson generator charged with wood carbon, considerable quantities of ammonia and hydrocyanic acid appear to be produced. If a mixture of air and ammonia is passed over the heated carbon (at a temperature of about 1100° C.) the yield of hydrocyanic acid is increased, and the amount of ammonia found exceeds that introduced with the air.—The estimation of the halogens in organic chloro-bromo-compounds: H. **Baubigny**. The method of combustion with sulphuric and chromic acids has been modified for the analysis of organic compounds containing both chlorine and bromine. Test analyses are given showing the exactness of the method.—A new method for the preparation of homologues of naphthalene: G. **Darzens** and H. **Rost**. An acyl derivative of naphthalene is prepared by Friedel and Crafts's method, and this reduced by hydrogen in presence of reduced nickel. The yields are quantitative, and the addition of hydrogen to the ring has not been observed.—The action of phenylmagnesium bromide upon the second methyl ester of paradimethylamido-orthobenzoylbenzoic acid: J. **Pérard**.—The formation of the cyanohydrin of benzoylacrylic acid: J. **Bougault**. The addition appears to be made at the ethylene linking, the acid formed being $C_6H_5.CO.CH_2.CH(CN).CO_2H$.—The anatomy and development of the embryo in palms, the Musaceæ, and Cannaceæ: C. L. **Gatin**.—The ecological characters of the southern region of Kabylie du Djurdjura: G. **Lapie**.—Simple schizogony in *Amoeba blattae*: L. **Mercier**.—The geology of the north and east of Corsica: E. **Maury**.—The migration towards the north of the watershed in the Lepontine Alps: Gabriel **Eisenmenger**.—The application of wireless telegraphy to weather forecasts: Alfred **Angot** (see p. 34).

## DIARY OF SOCIETIES.

*THURSDAY*, May 14.

Royal Society, at 4.30.—Croonian Lecture: The Structure of the Central Nervous System of the Higher and Lower Animals: Prof. Gustaf Retzius, For.Mem.R.S.

Royal Institution, at 3.—Mendelian Heredity: W. Bateson, F.R.S.

Mathematical Society, at 5.30.—On the Invariants of the General Linear Homographic Transformation in Two Variables: Major P. A. MacMahon.—On the Order of the Group of Isomorphisms of an Abelian Group: H. Hilton.

Institution of Electrical Engineers, at 8.—Switch Gear Control Apparatus and Relays for Alternating-current Circuits: Dr. C. C. Garrard.

Iron and Steel Institute, at 10.30 a.m.—On Improvements in Plate Rolling Mills: A. Lamberton.—On the Physical Qualities of Steel in Relation to its Mechanical Treatment: J. E. York.—On a New Fatigue Test for Iron and Steel: Dr. T. E. Stanton.—On an Experimental Electric Furnace for the Smelting of Iron: Prof. B. Igewsky.

*FRIDAY*, May 15.

Royal Institution, at 9.—The Past and Future of Tuberculosis: H. T. Bulstrode.

Iron and Steel Institute, at 10.30 a.m.—On Cast Iron in the Construction of Chemical Plant: F. J. R. Carulla.—On the Application of Colour Photography to Metallography: E. F. Law.—On the Utilisation of Blast-Furnace Slag for Portland Cement: C. von Schwarz.—On the Department of Metallurgical Chemistry in the National Physical Laboratory: W. Rosenhain.—On the Pyrometric Installation of the Ordnance Factories, Woolwich: J. Wesley Lambert.

Royal Society of Arts, at 8.—The Dangers of Coal Dust and their Prevention: W. E. Garforth.

*MONDAY*, May 18.

Victoria Institute, at 4.30.—On the Evidence of Malay, Javanese, Arabian and Persian Admixture in the Inca or Keshna Language of Peru, amongst the Aymara, the Language of the Peasant Class: F. W. Christian.

*TUESDAY*, May 19.

Royal Institution, at 3.—Light: What it is which Vibrates: Prof. F. T. Trouton, F.R.S.

Royal Statistical Society, at 5.

Royal Anthropological Institute, at 8.15.—The Pagan Gwari of Northern Nigeria: L. W. la Chard.

*WEDNESDAY*, May 20.

Royal Society of Arts, at 8.—Industrial Entomology: or the Economic Importance of a Study of Insect Life: F. Martin Duncan.

Royal Meteorological Society, at 4.30.—Upper Air Observations in Egypt: B. F. E. Keeling.—Balloon Experiments in Barbados, November 6–8, 1907: Prof. J. P. d'Albuquerque.—Observations on the Colour of Lightning, 1903–1907: S. C. Russell.

Geological Society, at 8. On some Cretaceous Fish-Remains obtained by Prof. Ennes de Souza from Ilheos, Bahia (Brazil): Dr. A. Smith Woodward, F.R.S.—On the Bala and Llandovery Rocks of Glyn Ceiriog (North Wales): Dr. T. Groom and P. Lake.

Royal Microscopical Society, at 8.

*THURSDAY*, May 21.

Royal Society, at 4.30.—*Probable Papers*: On Some Features in the Hereditary Transmission of the Albino Character and the Black Piebald Coat in Rats: G. P. Mudge.—A Further Note on the Nutrition of the Early Embryo, with Special Reference to the Chick: E. Emrys-Roberts.—The Antagonistic Action of Calcium upon the Inhibitory Effect of Magnesium: S. J. Meltzer and J. Auer.

Royal Institution, at 3.—The Chemistry of Photography: Dr. Alexander Scott, F.R.S.

Royal Society of Arts, at 4.30.—The United Provinces of Agra and Oudh: Sir J. J. D. La Touche, K.C.S.I.

Chemical Society, at 8.30.—Hydroaromatic Ketones, Preliminary Note: A. W. Crossley and C. Gilling.—Titani-dihydroxymaleic Acid, and the Detection of Titanium: H. J. H. Fenton.—Some Experiments on Carbon at High Temperatures and Pressures, and Apparatus Therefor: R. Threlfall.—The Sulphides and Oxy-sulphides of Silicon: I. G. Rankin and S. M. Revington.

Institution of Electrical Engineers, at 8.—Recent Progress in Tungsten Metallic Filament Lamps: H. Hirst.

Institution of Mining and Metallurgy, at 8.

## CONTENTS.

THURSDAY, MAY 21, 1908.

## HISTORICAL GEOGRAPHY OF AUSTRALASIA.

*Historical Geography of the British Colonies.* Vol. vi. Australasia. By J. D. Rogers. Pp. xii+440. (Oxford: Clarendon Press, 1907.) Price 7s. 6d.

ALTHOUGH the geocentric idea of the structure and movements of the universe was abandoned ages ago, mother earth must always remain as much the focus of interest to the dwellers on the globe as if it were still regarded as the point from which the heavens radiate and round which everything revolves. It is not surprising, therefore, that geography is assuming the position of the mother science, and tends to include, not only the physical features of the earth, but all the events which have taken place upon it.

Sir Charles Lucas appropriately names the series in which he describes the Britains beyond the sea a "Historical Geography of the British Colonies." Viewed in the modern manner, geography becomes invested with a human interest, and each country is dealt with as an organic entity. Dry bones are thus made to live. The study of the science is, as it were, transferred from the anatomical museum to the biological laboratory. Disconnected gazetteer paragraphs no longer suffice even for text-books, and for a volume with any pretensions some degree of style is now demanded; nevertheless, it is not often that we open the pages of a geography compiled with such artistic skill and clothed in such literary garb as "Australasia," vol. vi. of the series. Here we have an enormous mass of closely-packed information which would defy assimilation were it not traversed and lightened by veins of fancy in the form of apt similes and ingenious images which at once arrest the attention and fix the memory.

The volume deals with the most significant of modern developments, the transformation of the mystery of the old Pacific into the modern problem which confronts the civilised world. The story opens with a graphic account of the quest of the great South land of which the ancients dreamed. Eager was the search; Spain, Portugal, Holland and England panted in the chase. The privateering enterprise of England's sea dogs vied with expeditions equipped with all the resources of the mighty State of Spain. Every human motive was enlisted in the pursuit. The great unknown was adventured for the glory of God, for lust of conquest, for greed of gold, and for prospects of trade. The adventurers sought as saints, as soldiers, as misers, as bag-men. Human lives were as dust in the balance compared with the laying up of treasure here or hereafter. Quiros, a Spaniard, landing on one of the New Hebrides, imagined he had gained the goal, and called the island Australia del Espiritu Santo; this is the first mention of the term afterwards applied to the great island continent which emerged out of the turmoil of hope and disappointment.

The actual discovery of Australia was made from the Dutch East Indies, hence the name New Holland. The best part of Australia, the east coast, guarded towards the north by the Barrier Reef, remained a sealed book until the detailed investigation narrowed down into a rivalry between France and England. But though the ships of these two great colonising nations haunted and pursued one another as shadow and substance, the sincerity and high-mindedness of the commanders led to mutual aid and admiration, and not to conflict. As La Perouse remarked, all Europeans are compatriots so far from the home land. The history of the Pacific had hitherto been regarded as an inseparable whole; henceforth this homogeneity becomes particulate. In accordance with the laws of evolution, the New Pacific advanced towards organisation by a separation into parts.

The political history of Australia falls within three epochs. The first epoch was undiluted socialism. In the beginning was the State which fed, clothed, and employed every man; but as wealth increased private enterprise grew. The State, which at that time meant England, gradually became a total abstainer from production and industry; then, as under increasing autonomy, the State became identical with the Colony, private enterprise was fostered by grants in aid; important works, such as railways and waterworks, being undertaken by governments, which extended their activity in many other directions, so that since 1890 State socialism has been reintroduced in a way which vividly recalls that of the first epoch.

This aspect of State action alternating with individual action is both interesting and instructive as bearing on the much-vexed question of socialism. Evolution advances at one time by the impulse that makes for difference, and at another by that which induces agreement; the first shows itself in the diversified activities of the individual, the second in the corporate action of the municipality or State. Thus difference in agreement becomes harmony. Both tendencies are essential, and the individuals who denounce socialism as altogether evil are no more enlightened than those socialists who seek to minimise the importance of individual initiative.

Mr. Rogers deals with the pioneer laws of Australia and New Zealand in the matter of industrial arbitration. The wages boards, which, originating in Victoria, have done so much to stamp out sweating, are of special interest at the present moment, when it seems likely that the mother country will, in this as in so many other cases, follow the lead of the daughter States. In an appendix to the first portion of the volume a graphic account is given of the constitution of the Australian Commonwealth.

The second portion of the volume is devoted to geography pure and simple, and here the method of the first, or historical, portion is reversed, for whereas the history began with continents and ends with islets, the geography, in accordance with modern custom, proceeds from the local to the general; "the wayside flower will be examined before the garden and the garden before the forest." The book is a living entity which cannot be dealt with after the methods of the dissecting room; it must be read as a whole to be appreciated. Its perusal will be found to give both pleasure and a real acquisition in knowledge. Mr. Rogers is to be congratulated on the production of a volume in every way worthy of its place in a series designed by one so conversant with our colonial empire as Sir Charles Lucas.

John A. Cockburn.

## BRITISH ASCIDIANS.

*The British Tunicata.* An unfinished Monograph by the late Joshua Alder and the late Albany Hancock. Edited by John Hopkinson. Vol. ii., with Lives of the Authors by Canon A. M. Norman, F.R.S., and the late Dr. Dennis Embleton. (London: Ray Society, 1907.) Price 25*s*. net.

THE first volume of this work was published in 1905, and was noticed in Nature in the following year (vol. lxxiii., p. 508). So far as the so-called "simple" and "social" Ascidians are concerned, the work is now complete. No statement is made as to whether we are to expect a third volume on the "compound" Ascidians. We understand, however, that such a volume is in preparation, and that it will include a bibliography of the Tunicata by the editor. We may repeat our congratulations to the Ray Society for publishing this long-lost work, and to Mr. Hopkinson for his careful editorship under many difficulties. The numerous coloured and photographic plates included in this volume maintain the same high standard as in its predecessor, and the lives of the authors, by their friends Canon Norman and the late Dr. Embleton, which are prefixed to this volume, are full of interest for all who can appreciate the simplicity of nature and patient genius of two of the most distinguished pioneers in the field of British marine zoology.

Mr. Hopkinson has, with one exception, limited his notes to the addition of bibliographic and distributional records published before 1871. The monograph consequently possesses as nearly as possible the character which it would have assumed if it had been published in the latter year, two years before Hancock's death.

The present volume deals with Ciona and Corella among the Ascidiadæ, and with the families Molgulidæ, Cynthiadæ, and Clavelinidæ, in the broadest sense of these various terms. Between fifty and sixty "species" are described, of which no less than eleven are put forward as new. Three of the latter are referred to the genera Molgula, Cynthia and Clavelina respectively, two to Styelopsis, and six to Styela. In most of these cases it is more than doubtful whether the characters relied upon by the authors possess sufficient stability to serve as a criterion of specific differences. Some of these "new species" are undoubtedly mere variants from common types, together with other forms which are described in the monograph under names previously conferred upon them by the authors and other naturalists. The "new" species *Clavelina corrugata* is described as differing from the common *C. lepadiformis* merely in the wrinkling of the test and in the pinkish colour of the pharyngeal stripes, which are white or yellowish in the common type. A single tide-pool on the Devonshire coast will occasionally show half a dozen equally well-marked variants from the same type.

It would be tedious, as well as unprofitable, in this notice to enter upon a detailed comparison of the authors' nomenclature of recognised species with the systems in current use. But it is to be hoped that the publication of this monograph will not have the result of introducing further confusion into a subject already sufficiently tangled, in which the more critical revision work of the last twenty years has not yet produced complete concordance of results. The revival of Müller's *conchilega* for a species of Molgula is particularly unfortunate, for there is good reason to regard Müller's type as a common species of Ascidia, while Alder and Hancock's *Molgula conchilega* is plainly identical with Kupffer's *Molgula occulta*. It is doubtful, by the way, if Mr. Hopkinson is justified in assigning to this species the various records of *Ascidia conchilega* which have been based upon Müller's original description. The substance of a remark which I made in my previous notice may be fitly repeated, that the monograph, after all these years, must be cautiously used as a repository of descriptions and figures, but not as a guide to the classification or nomenclature of the group.

In one respect Mr. Hopkinson has departed advantageously from his rule not to add any observation of later date than 1870, since he has incorporated a definition of the genus Styelopsis, which was founded in 1882 by Traustedt for the common *Styela grossularia*, a species which Alder and Hancock themselves recognised as markedly distinct from the other species of Styela. In these circumstances the editor might well have pointed out that the form described by Victor Carus as *Thylacium sylvani*, which is included in this monograph under that name, is in all probability nothing but *Styelopsis grossularia*, of which the young individuals, fixed on the tests of the parents, had been erroneously regarded as evidence of gemmation. I can confirm all that Michaelsen has recently said on this point ("Revision der compositen Styeliden oder Polyzoinen," Hamburg, 1904), with some additions, since in 1891, with the permission of the Linacre professor, I dissected a portion of Carus's type in the Oxford Museum, and found it to be identical in structure with *S. grossularia*, while the so-called buds were true metamorphosed larvæ, possessing characteristic protostigmata (Proc. Royal Soc., li., pp. 505–13). In the following year also I searched the original locality, and many others, in the Scilly Islands, and found the same species covering the rocks in immense numbers, as described by Carus in the case of *Thylacium sylvani*. It is interesting to notice that in this monograph Alder and Hancock record the fact that they also had "seen" the original specimen in the Oxford Museum, and record their doubts as to the existence of gemmation, as well as their impression of the "very close resemblance between the *Thylacium sylvani* and some of the smaller gregarious Cynthiæ already described." The only discrepancy in this interpretation is the fact that Carus recorded *Cynthia rustica* (=*S. grossularia*) as well as *T. sylvani* from the Scilly Islands. Presumably the former term was restricted to the less crowded clusters in which the larvæ had not fixed themselves to the bodies of their parents.

WALTER GARSTANG.

## PRINCIPLES OF BREEDING.

*Principles of Breeding. A Treatise on Thremmatology.* By E. Davenport, with appendix by H. L. Rietz. Pp. xiii+727. Country Life Education Series. (Boston, New York, Chicago, London: Ginn and Company, n.d.) Price 12s. 6d.

THIS is the first serious attempt to present a modern scientific text-book on the principles of breeding (or, as the author prefers to call it, thremmatology) to English-speaking agricultural students, in which recognition is accorded to much of the recent work done on genetics and some other branches of the physiology of the generative system, and in which effort is made to show the essential value of that work to breeders. The book is most welcome, and our thanks are due for it to the professor of thremmatology in the University of Illinois.

The author's idea of what is needful for the education of an agricultural student is very far in advance of what is usually considered sufficient for that purpose; his book is adapted not only to convey a much wider knowledge of scientific work than has been hitherto thought necessary, but to demonstrate the direct effect such work must have on the fortunes, the ultimate success, of the modern practical breeder.

In spite of the fact that Prof. Davenport declares the breeder of the future will be a book-keeper and statistician, his book shows he has a somewhat wider appreciation of the breeder's qualifications than these words indicate. At the same time, it does seem possible that his enthusiasm for the pure science of genetics has led him to load his book somewhat too heavily with figures, and to neglect to inculcate with sufficient force the necessity for a breeder's close attention to and intimate knowledge of the capacities and peculiarities of individual members of a flock or herd. This is, in our opinion, a serious defect in a text-book for agricultural students; the power of close observation is an essential qualification for a breeder.

Similarly, the author's endeavour to induce the student to take "short cuts" to success is to be deprecated. He urges "A man must realise the fruit of his own labours." "The breeder must therefore work faster than nature." The "evolutionary principle" must be accelerated; and so forth. In so far as it is possible to gain these ends his attempts to further them are good, but he omits to point out that at the best these ends can be only partially gained, and that the evolutionary principle cannot be accelerated sufficiently to *satisfy* individual aims. He notes that "experience shows that the purposes, standards, and methods of a successful breeder are seldom handed down from one man to another," but he does not attempt to point out the means whereby this can be obviated, and yet it is the most severe handicap to progress which breeders suffer from.

There is one great opportunity which all professors of a big agricultural college have to their hand, that of organising a system of records of the practical results subsequently gained by all the students which pass through their schools. Such records, compiled by men trained by modern scientific methods and made available for use at their college, would be of incalculable value, both to the professors and the breeders of future generations; in order to carry out such a scheme, however, the student must be taught to understand that there are no short cuts to knowledge, and that the only way they can hope to accelerate the acquisition of knowledge of evolutionary principles is by pooling their experiences, their failures as well as their successes.

Part i., on variation—the author makes variation rather than heredity the initial leading thought of his scheme, putting the cart before the horse and thereby somewhat confusing the issue—is a brief *résumé* of some of the leading features of that branch of the subject, instances being given of a kind specially suitable to stimulate the interest of American students, for whom the book is written.

Part ii., on the causes of variation and the relative stability of living matter, and part iii., on transmission, constitute the bulk of the book. The author's clear and forcible writing, the thoroughness of his treatment, the arrangement of his facts, and the wealth of illustration he gives are worthy of great praise. These sections are not only a valuable summary of what is known, but contain much original thought, and deserve the attention of all students of the subject.

Part iv. is on practical problems. Those dealt with under the headings selection, systems of breeding, plant breeding, and animal breeding are full of good common sense and sound advice; any breeder would do well to consult them.

Thus if it has failings the book has great merit, and it is to be hoped the example set by Prof. Davenport will be followed in this country, where the education of agricultural students in the science of breeding is sadly behindhand.

## THERMOCHEMISTRY.

*Thermochemistry.* By Julius Thomsen; translated from the Danish by Katharine A. Burke. Pp. xv+495. (London: Longmans, Green and Co., 1908.) Price 9s.

OWING to the rapid strides which have recently been made in physical chemistry, the subject of thermochemistry, which is itself of a physical nature, has been rather left in the background. At one time it was hoped that thermochemistry would be of very great help in elucidating the hidden laws governing chemical reactions, but unfortunately it has hardly realised expectations.

Although a very large amount of work has been done upon this subject, we can hardly say that it has been found possible to rely upon thermochemical methods to give us more than a general idea as to the course of reactions. At the same time, it is by no means a subject which can be dismissed as being useless, because a very great deal of help may at times be obtained by the study of thermochemical data. For example, in manufacturing operations, it is of the first importance to know heats of combustion, because the number of calories required to decompose a substance is of course a guide to the manufacturer in connection with the energy required in a given process.

Quite recently Prof. J. W. Richards contributed a very useful and interesting series of papers in an American technical journal upon the thermochemistry of metallurgical processes. Furthermore, the subject is of great importance to the electrochemist, who is able to determine the voltage necessary to be employed in an electrolytic process if he knows the heats of combination of the compound. Or we might take another example. In aluminothermics it is owing to the very high heat of formation of aluminium oxide that such an enormous amount of heat is given out when aluminium reacts with certain metallic oxides, and consequently one can tell beforehand whether a given oxide will be readily reduced by means of aluminium or not.

Of all the workers in the field of thermochemistry none has done such thorough, careful, and pioneering experimental work as Julius Thomsen, and it was a happy idea of Sir William Ramsay to include a translation of Thomsen's Dutch work in the well-known text-books on physical chemistry which are now finding such an important place in the chemical literature of the country; and we may say at once that Miss Burke has done her part of the work extremely well. As she states in the preface, it has been necessary at times, owing to the advance in other branches of physical chemistry, slightly to alter the reading of certain sentences; for example, taking her own illustration, where Thomsen has used the expression "Neutralisation is regarded as a union of acid and base, with formation of water," Miss Burke has changed this to "Neutralisation is regarded as a union of acid hydrogen and basic hydroxyl to form water." Undoubtedly some chemists will take exception to such an alteration, and will say it is pedantic and unnecessary, particularly those who are not attached to the ionic theory, and, after all, there are a goodly number who consider there are many difficulties which require to be cleared up before the ionic hypothesis can be considered fundamental.

The first portion, the introduction, introduces the subject with an explanation of experimental calorimetric methods, the apparatus being described and illustrated, and the methods of using it fully gone into. Chapter i. deals with the absorption of gases and the heat produced when they, liquids or solids are dissolved in water, and a number of tables are given, with the thermochemical data. The next chapter deals with the rather complicated question of heat of hydration; the methods of calculation for obtaining the heat formation of different compounds, provided the heat formation of certain substances is known, are carefully set out throughout the pages. The book not only deals with inorganic compounds, but also with a very large number of organic substances, the tables in chapter xii. being exceedingly full. An interesting part of this chapter is that in which the heat formation of isomeric compounds is given. Thus the difference of heat formation of propyl and isopropyl alcohol is 5·3 cal., that between isobutyl alcohol and trimethyl carbinol being 17·15 cal.

In fact, the book deals with Thomsen's work, and will undoubtedly be found extremely useful to any investigator who wishes to study this branch of the subject, and as a book of reference to be kept in all chemical libraries, though hardly, we think, for general reading, as it is rather too full for this purpose.

F. M. P.

## MATHEMATICAL TEXT-BOOKS.

(1) *The Elements of the Geometry of the Conic.* By Prof. G. H. Bryan, F.R.S., and R. H. Pinkerton. Pp. xi+270. (London: J. M. Dent and Co., 1907.) Price 3*s.* 6*d.*

(2) *Geometry, Theoretical and Practical.* By W. P. Workman and A. G. Cracknell. Part ii. Pp. ix+(330–535). (London: W. B. Clive, 1908.) Price 2*s.*

(3) *Practical Integration for the Use of Engineers, &c.* By A. S. Percival. Pp. vi+86. (London: Macmillan and Co., Ltd., 1907.) Price 2*s.* 6*d.* net.

(4) *Integration by Trigonometric and Imaginary Substitution.* By C. O. Gunther. Pp. vi+79. (London: A. Constable and Co., Ltd., 1907.) Price 5*s.* net.

(5) *A Course in Mathematics for Students of Engineering and Applied Science.* By F. S. Woods and F. H. Bailey. Vol. i., Algebraic Equations, Functions of one Variable, Analytic Geometry, Differential Calculus. Pp. xii+385. (Boston, New York, Chicago, London: Ginn and Co., n.d.) Price 10*s.* 6*d.*

(1) THIS is an attractive little book on geometrical conics. The argument is very clear, and presents the subject to a beginner in the simplest possible manner. The difficulty in writing a text-book of this sort lies in the fact that many properties of conics are far more easily treated by analytical than geometrical methods. The authors have met this difficulty by putting first those results which lend themselves more readily to geometrical proofs; other theorems are left until later on, and then the methods, if not the nomenclature, are analytical. A reasonably large number of examples is given, which are nearly all of a graphical or numerical nature. This is a pleasing innovation, and theoretical examples can be supplied by the teacher, if required, from almost any other text-book. A property of the parabola is discussed at the same time as the corresponding property of a central conic; much might be said both for and against this course. Many of the proofs are ingenious; the construction of the hyperbola by means of string and pins alone is worth noticing. A chapter is given in which are discussed those properties of the cycloid, catenary, &c., which can be proved without the aid of the calculus.

(2) This book covers the ground of Euclid ii., iii. 35 to 37, iv., and vi., together with the properties of harmonic (but not of anharmonic) ranges, the nine-point circle, the radical axis, poles and polars, inverse figures, &c. The text is on the whole more theoretical than practical; the examples are divided into theoretical riders, practical constructions, and calculations, a good and sufficient collection of each being given. The book contains rather more than the average student will require; the authors asterisk some of the less necessary sections, and probably the teacher will advise the omission of others also. The properties of rectangles are developed from the geometrical standpoint; algebraic methods are, however, also given. In the theory of proportion only commensurable quantities are dealt with at first, the extension to incommensurables being given in the last chapter. The book is sound and sensible throughout, and deserves to hold its own easily in the severe competition which text-books on elementary geometry have to face at present.

(3) The author starts by defining integration as the inverse of differentiation, and then shows how to find the indefinite integrals of all the usual standard types. This part of the book may be quite useful, but the latter portion is not so satisfactory. The author has attempted too much for the space at his disposal, and sacrifices in places not only soundness but intelligibility also. Definite integrals are introduced without any adequate explanation, and the connection between definite and indefinite integrals is obscure. It is almost impossible to make applications of the calculus to geometry clear without a single diagram or without proving that a definite integral may be considered as the limit of a sum; this is, however, what the author attempts. In fact, the argument is too condensed to be followed by the type of student for whom the book is written; for instance, such a step as " $-d\theta/dt=a\theta$, $\therefore d\theta/\theta=-adt$ " is sure to give trouble if unexplained.

Minor errors are the statement of the "test-ratio" rule on p. 36, and misprints at the bottom of pp. 42, 43. A book which aims at being "practical" should not calculate the temperature of a cup of tea to four places of decimals.

(4) This book is very short; for the margins and print are large, while twenty-six of its seventy-nine pages are occupied by a somewhat superfluous introduction, and fifteen by solutions of examples. The remainder is devoted to the indefinite integral of $\cos^m x \sin^n x$ ($m$ and $n$ integral) without the aid of reduction formulæ, and to the integral of expressions involving $\sqrt{a^2-x^2}$, $\sqrt{a^2+x^2}$, &c. This latter part is done better in other books; for surely in integrating $\sqrt{a^2+x^2}$ the substitution $x=a \sinh\theta$ is preferable to $x=2a \sin\theta$.

(5) This book is intended to cover the mathematics learnt in the first year of a two years' course at an engineering school. The authors disregard the traditional division of mathematics into distinct subjects, and introduce the principles of each subject as needed. By thus developing algebra, analysis, and calculus side by side the student has his interest stimulated, realises the interdependence of different parts of mathematics, and learns the art of choosing the best method of attacking any given problem. Against this must be set the fact that the conventional division of mathematical study has the great advantage of helping the student to systematise his knowledge. If once we admit the principle of no division, we could hardly wish for a better book. The subjects are very skilfully coordinated; the treatment throughout is sound and mathematical without ceasing to be interesting or "practical." The examples are useful and very numerous, and answers are given. In this first year's course is covered a good deal of the more elementary parts of the theory of equations, determinants, graphs, analytical geometry as far as the general equation of the second degree, and differential calculus, including curvature and critical values of functions, but not asymptotes. Conics, especially geometrical conics, are treated less fully than usual; their place is partly taken by other interesting curves. Excellent and interesting though the book is, it makes heavy demands on the reader's attention; and would probably require considerable ability on his part if it is to be mastered in one year.

## OUR BOOK SHELF.

*Nephilim.* By William J. H. Bohannan. Pp. 236. (New York: Reeve A. Silk, 1908.) Price 1.50 dollars.

"THIS book is written," so we are told, "to show the error of 'science,' and to point out the truth of statement of the Bible concerning physical phenomena."

It certainly does show the error of "science," as understood or misunderstood by the author of the book. The following extracts are given merely as examples of the style in which the book is written:—

"The more the thermic dominates in structural composition of a body, the more penetrable it is to the magnetic entities of the field of another and the less to the thermic of that field."

"The earth's thermic entities of field, emitted from her equatorial region, her southward geographical pole being toward the sun, were taken outward from him, under the action of the entities of his field, her inseparable thermic entities of field enveloping the separable of her northern regions."

As a further example, we are informed by way of correction that "Nephilim," p. 154, fourth sentence, should read: "The planet Jupiter, on the other hand, had three tails, two visible to human eye, passing outward from the poles of the planet and from the sun; the other one magnetic and invisible, but vastly greater than the visible, passing from the equator of the planet toward the sun."

Some of the chapters suggest a kind of vortex theory, while others profess to deal with the theory of the tides. The author of "Nephilim" would have stood a better chance of recognition if he had made a careful study of the whole existing literature on one or other of these two subjects. The mere quotation of extracts from articles in popular encyclopædias, the contributors of which were probably limited to 1000 or 2000 words, is a very small step in that direction. Such short articles were never intended to give a complete explanation of all the difficulties which have been studied in connection with these theories;

*e.g.* the difficulties which the author raises in connection with the energy of wave motion. No good can come of ignoring the vast number of papers that have been published dealing with such difficulties.

There are hundreds of books already written in the same polemic spirit as "Nephilim." The author of each of these books believes himself to be right and everyone else to be wrong, and nearly every possible permutation of the words "force," "energy," "atom," "ether," "gravitation," and such like is represented in the different meanings (if any) the different writers attach to these terms. It would be well if future would-be writers of such books would try their hand at evolving some kind of order out of this tangled mass of mutually contradictory tirades before adding to the collection.

*Le Principe de la Conservation de l'Assise et ses Applications.* By George Matisse. Pp. 65. (Paris: Libraire scientifique, A. Hermann, 1907.) Price 2.50 francs.

This small pamphlet describes clearly and simply certain applications of Carnot's principle to physical problems. The unique feature of the book is indicated in the title. The word "assise" groups together certain variables which refer to distinct physical quantities, but which enter into the equations of energy in the same manner. The only equivalent English word we can suggest is the word "fundamental." The solution of many types of problem may then be said to depend on the two principles of the conservation of the fundamental and the conservation of energy. The differential of energy depends in general on a product of the form $xdy$, the precise meaning of $x$ and $dy$ depending on the kind of problem under contemplation, electrical, thermal, elastic, mechanical, or chemical, as the case may be. In these several cases the "assise," symbolised above by $dy$, is respectively electric quantity, entropy, volume, length, and mass. Such quantities all obey the conservation law, which the author concisely defines in these words:—Under the action of physical and chemical phenomena there can be no creation of electricity, of space (linear or cubical), of entropy, or of matter. Four applications are given in which the principle of the Carnot cycle is ingeniously utilised. The novel use of the word "assise" seems to be the main feature of the pamphlet; otherwise there is not much which calls for special remark.

*The Case for the Goat.* With the practical experience of twenty-four experts. By "Home Counties." Pp. x+162. (London: George Routledge and Sons, Ltd., 1908.) Price 3*s.* 6*d.*

It is hoped this little book may help to remove ignorant prejudice against the goat, and induce small holders, labourers, and many rural residents to keep this valuable animal. The advantages to be derived from the "poor man's cow" are very imperfectly known in England, and the author sets himself to show what they really are. Goat's milk, he points out, is often as rich again as cow's milk; it may practically be guaranteed to be free from the bacillus of tuberculosis, and is a very valuable food for children, especially for those who cannot digest cow's milk. Moreover, the amount of milk goats yield, and the ease with which food is to be found for them—they will pick up a living in the hedgerows—ensures a very cheap supply of food for rural owners; while they thrive as hand-fed occupants of back yards in the suburbs, and require no more space than a big dog.

The author complains that the Board of Agriculture does not see its way to include the goat in its agricultural census, treating it as a negligible quantity, while a further bitter grievance against the Board is due to its refusal to permit the importation of new blood under guaranteed restrictions, when the goat stock of the kingdom is suffering from in-breeding to a deplorable extent. Less than a score of stock goats are urgently required for this purpose, and the Board's action is not inaptly described as "an oppressive absurdity."

The different breeds of goats suitable for this country, their management, breeding, and the substantial profit to be made out of them is clearly set forth. It is an interesting little book, and the author surely proves his case.

*Confessio Medici.* By the writer of "The Young People." Pp. xi+158. (London: Macmillan and Co., Ltd., 1908.) Price 3*s.* 6*d.* net.

"Confessio Medici," a title which naturally recalls that of another book by a great physician, need not fear comparison even with Sir Thomas Browne's immortal work, and surely no higher praise can be accorded it. In a series of essays on such subjects as "vocation," "hospital life," "practice," "retirement," "the very end," &c., the author presents to the reader a survey of the responsibilities, the foibles, the hopes, the failures of medical practice. We wish that every student of medicine during his student days would read, mark, learn, and inwardly digest their practical wisdom and happy maxims, and many a practitioner whose finer feelings have perhaps become blunted by too close contact with a stringent life would rise up the better from their perusal.

## LETTERS TO THE EDITOR.

*[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.]*

### Who Built the Aberdeen Stone Circles?

In an article in Nature of April 9 dealing with the orientation of the Aberdeen stone circles, Sir Norman Lockyer says:—"Another of the associated inquiries will be to see if the area of the recumbent stone has also special ethnological or craniological characteristics." It may be of interest, in this connection, to point out that the short cist skeletons in the anatomical museum of Aberdeen University have been derived from an area coinciding very closely with that of the Aberdeen stone circles. These skeletons have been recently measured by Dr. Low (see Proceedings of the Anatomical and Anthropological Society, University of Aberdeen, 1902–6), and the measurements, as I showed in a paper read before the British Association at York, reveal the existence, in the early Bronze age, in this district, of a race significantly different from all the prehistoric racial types previously determined in Britain. This race is hyperbrachycephalic, having an average cephalic index of 85, and it is of short stature, 5 feet 3 inches. It differs from the Neolithic race, which was markedly dolichocephalic, and it also differs from the Bronze age race of the round tumuli, whose index was 78 and stature 5 feet 9 inches.

The origin of this prehistoric Aberdeenshire race, with a cephalic index so much higher than that of all known races in neighbouring countries, is at present one of the unsolved problems of British ethnology. Its close association with a special form of stone circles may help to throw some light on the origin of these interesting monuments, as well as on its own.

J. Gray.

London, S.W., May 11.

### Radio-activity of Potassium and other Alkali Metals.

PROF. McLENNAN's letter in NATURE of May 14 (p. 29) makes it desirable that I should record that my experiments continue to be in contradiction to those he describes. Whether the activity of potassium is due to an extraneous impurity or to the element itself, it is to be expected that some separation of the activity should be possible. For the last year and a half I have been trying to effect such a separation without result. All samples of the same pure salt which I have procured or prepared are identical in activity. In one experiment a sample of the sulphate was crystallised twenty-two times, in another a sample of the nitrate was crystallised eighteen times without introducing any difference between the final products; in a third a sample of potassium sulphate was prepared direct from wood ashes, and found to agree with a commercial sample prepared from the Stassfurt deposits. I propose now to prepare a third sample direct from felspar.

The only difference which I can detect between Prof. McLennan's experiments and my own lies in the fact that he places the active material inside the ionisation vessel, while I place it outside an aluminium window. If he were measuring the effect of very soft rays, the difference between our results might be explained.

NORMAN R. CAMPBELL.

Trinity College, Cambridge, May 14.

### On Dispersion and Spectrum Series.

IN reply to Mr. Campbell's letter of April 30, it must suffice to point out that my letter of March 5 was limited to infinite spectrum series and to luminous gases. This seemed to me at the time of writing obvious from the context, as well as from the express reference to the finiteness of the refractive index of *luminous* hydrogen. Apparently I was mistaken; anyhow, Mr. Campbell's suggestion that I confused the emission lines of luminous with the absorption bands of dark hydrogen rests on a misconception of my meaning.

To avoid further misunderstanding, I will add that by "electrical theory of absorption and dispersion, of magnetic rotation and Zeeman effect," I mean, of course, the theory of Drude, together with its extension by Voigt to *all* magneto-optic phenomena; I do not mean theories such as those of Lorentz and Ritz, which deal with the Zeeman effect alone. I know no reason for confining that theory to one member only of a series, *e.g.* the D lines of sodium, and contend that it leads to contradictions when applied to all the members of an infinite series of similar lines.

The remaining points raised by Mr. Campbell seem to me foreign to my argument. I cannot discuss them in the space at my disposal here, but hope to do so elsewhere.

Bonn, May 8. G. A. SCHOTT.

### Secondary Waves of Light.

IT has hitherto been held that, so long as the diffraction apertures used (cut in perfectly opaque or perfectly reflecting screens) are large compared with the wave-length of light, Fresnel's expression for the amplitude of the disturbance due to a surface-element gives us a close approximation to the observed diffraction effects, and that the exact value for the obliquity factor is of little importance (*e.g.* see Schuster's "Optics," sec. 48). That this is true only in the special case in which the apertures are held normal to the waves of light, and not in other cases, is shown by some new diffraction phenomena that I have made the subject of study.

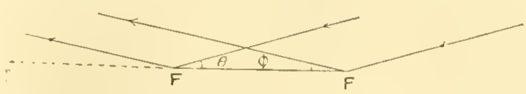
The only experiment so far known which might seem to show effects due to the obliquity factor is the well-known one with the circular disc, but it is really inconclusive. The observed fact, that the illumination along the axis of the disc decreases as the disc is approached, is more or less entirely due to minute irregularities in the rim of the disc, and not, as is sometimes stated, to the increasing obliquity of the secondary waves producing the illumination.

The theoretical grounds on which my experiments were based were these:—if diffraction bands are produced and observed in a direction in which the amplitude of the disturbance in the secondary waves varies rapidly from point to point, we might expect effects due to varying obliquity. Such effects would obviously not occur if the diffraction aperture or mirror is, as is usual, held normal to the waves of light incident on it, but might if it be held obliquely.

In the *Philosophical Magazine* for November, 1906, I showed that the diffraction bands due to a rectangular aperture held very obliquely are not equidistant, that the band-width increases progressively from one side of the pattern to the other, and that the number of bands on one side of the pattern is limited. They are most easily seen on the spectrometer if the image of the slit of the instrument formed by light reflected very obliquely from the face of a prism is observed. The positions of the minima of illumination, actually observed, are closely in agreement with those calculated from the usual formula ($\cos\theta - \cos\phi = \pm n\lambda/a$), $\theta$, $\phi$ being the complements of the angles of incidence and diffraction. Further observations have elicited the following:—from the expression for the intensity of the illumination in the pattern deduced by the ordinary method

$$I = a^2 \sin^2 \frac{\pi a}{\lambda}(\cos\theta - \cos\phi) \div \frac{\pi^2 a^2}{\lambda^2}(\cos\theta - \cos\phi)^2,$$

it would appear that the maxima of illumination in corresponding bands on either side of the middle one should be of equal brightness. This is flatly contradicted by observation, both visual and photographic. It is found that the bands on one side are considerably fainter than those on the other, and this difference becomes very large as the light approaches grazing incidence. The illumination in the diffraction pattern (with a given angle of incidence) decreases and dies away as we approach the limiting plane of the fringes, which is the plane of the reflecting surface (FF in the diagram).




This effect is inexplicable if the question of the variation of the amplitude in different directions of the secondary waves, supposed to be sent out by the elements of the reflecting surface FF, is not taken into account. It must be remembered that we are not dealing with apertures small compared with the wave-length; both the aperture and its projection are large compared with $\lambda$, and there are no polarisation effects observed. The question may be attacked analytically, and it can be shown that an element of the surface of a reflecting body is equivalent in its effect to a double source of appropriate intensity which, it is known, produces zero effect in its equatorial plane and a maximum along its axis. The effect of an element of the surface FF is therefore zero along the line FF, and in other directions increases as we move away from the line FF. Remembering that the elements are not in the same phase, and integrating their separate effects, we get an explanation of the phenomenon observed.

A fuller discussion and a mathematical investigation will be published in due course. I found that similar effects are observed when the transmitting aperture is used. Some experiments with coarsely ruled gratings are in progress which seem to point in the same direction.

C. V. RAMAN.

Science Association Laboratory, Calcutta, April 2.

### The Corrosion of Iron and Steel.

IN NATURE of May 14, Dr. J. Newton Friend alludes to *Gallionella ferruginea* as obtaining its life's energy by oxidising ferrous carbonate and organic ferrous salts, causing the precipitation of rust, or ferric hydroxide. May I point out that *Gallionella ferruginea* can live and grow well without any iron at all, and so cannot be a vital factor in the metabolism of the bacterium, using the term "bacterium" in its widest sense? The oxidation which takes place can be simply explained by the fact that ferrous carbonate in solution is very unstable, becoming very rapidly oxidised.

W. F. MACFADYEN.

54 Dunard Street, Glasgow, May 16.

## INVESTIGATION OF THE UPPER ATMOSPHERE.

THE work carried out in England in connection with the investigation of the upper atmosphere forms part of a wide and well-organised scheme. On certain days appointed by an international committee, balloons and kites are sent up from some thirty stations scattered all over the world. The kites are used for the study of the lower layers, and free balloons for greater altitudes. In a discussion bearing on the isothermal layer we have therefore only to deal with the latter.

Abroad, instruments of many types have been designed and improved by Hergesell, Assmann, Teisserenc de Bort, and de Quervain. The fact that nearly twenty different modifications exist is sufficient excuse for not undertaking here an analysis of their respective merits. These instruments cost from 10*l.* to 12*l.*, and their weight, which exceeds a pound, involves the use of relatively large and expensive balloons.

In Continental countries but few instruments are permanently lost, and as very substantial Government grants are in most cases available, the question of working expenses is not of vital importance. In England we are financially and geographically less favourably situated, and there is little doubt that but for the energy and inventive genius of one man, little work would have been attempted.

The Dines balloon meteorograph costs one-tenth and weighs one-eighth of the corresponding Continental instruments. The record, though microscopic, is nearly *indestructible*, for it is engraved by two sharp styles on a sheet of copper. This constitutes an important improvement, for the ordinary smoked record is not infrequently obliterated by the time the instrument is returned.

The record consists of fine lines, which remain parallel as long as the temperature remains constant. The bimetallic thermograph is carried on a support which is moved by the barograph. In ordinary circumstances a curve is obtained for any point of which the abscissa measures the deflection of the barograph, and the ordinate minus a constant the deflection of the thermograph.

The calibration of the thermograph is a simple matter, the deflection being practically a linear function of the temperature. The calibration of the barograph, on the other hand, offers considerable difficulties.


Variation of Atmospheric Temperature with height on April 2, 3 and 4, 1908.

In order to increase the sensitiveness of the instrument without adding to its weight, it is necessary to leave a certain amount of air in the aneroid box. This, as also the change of elasticity of the metal, causes the calibration of the instrument to vary considerably with temperature, and adds materially to the labour involved in reducing the results.

After trying and abandoning various methods of approximation, Mr. W. A. Harwood, who is in charge of this branch of the work at Manchester, now draws out for each instrument a number of independent calibration curves, each one referring to one definite temperature. These form a series of nearly parallel curves, which cover the range of temperature and pressure over which the instrument is used. The calibration made before the ascent is verified after the return of the meteorograph.

The accuracy obtainable of course decreases with the density of the air; over the first few kilometres a difference of level of less than a hundred metres is easily measured, but when the height attained is such that the prevailing pressure is only one-tenth of an atmosphere, the possible error becomes considerable.

The diagram here given, which refers to the last date on which balloons were sent up on three consecutive days, is a typical example of the results obtained. The Manchester record for January 2 lies between the Pyrton Hill curves for January 3 and 4 up to about 9 km., above which height the temperature remains constant for some distance. Two traces were inscribed by the instrument sent up from Manchester on January 4. Probably in this case, as occasionally occurs, the balloon did not burst and fall at once on attaining the maximum height, but drifted down slowly as the gas diffused out. In such cases the time to which the second trace applied cannot be determined, and the rise of temperature might well be due to the next day's solar radiation. Trustworthy or otherwise, this trace has its place on the present diagram, the primary object of which is to give a complete collection of the results obtained from one set of ascents. The Pyrton Hill balloons were sent up at 3 p.m., and the Manchester ones at 6 p.m.

It is noticeable that during the three days the average temperature gradients between 2 and 8 kilometres (*i.e.* above the disturbing influence of the ground, but below the level of the isothermal layer) remained practically constant, whereas a considerable difference existed between the temperature of the isothermal layer as measured on January 2 and 3.

Generally speaking, many improvements of the methods and instruments are doubtless still required, but it must be remembered that the work in England was commenced less than a year ago, and perfection can hardly be expected within so short a time.

J. E. PETAVEL.

## HOME AND FOREIGN BIRD-LIFE.[1]

THE authors of these three excellent little works are evidently enthusiastic bird-lovers and accomplished and patient observers. In the case of the first two, at any rate, their highest enjoyment appears, indeed, to consist in sitting for hours watching the movements and ways of their feathered favourites. Moreover, either they or their friends are well accomplished in the use of the camera, and they have thereby been enabled to make permanent records of many of the fascinating sights that have come under their observation for the benefit of those who have neither their patience nor their opportunities.

Mr. Gordon's favourite species appear to be the golden eagle and the ptarmigan, the photographs of both of which are claimed to be nearly, if not indeed completely, unique. To obtain the picture of the golden eagle's eyrie the author underwent considerable difficulty not unmingled with danger, while peril of another type was experienced when a fog suddenly descended as he was wandering among snow-clad precipices in search of ptarmigan. The photographs have therefore more than their apparent face-value, which is of itself considerable. Where all are interesting it is difficult to make a selection, although personally we have been much interested in the series of photographs of a young golden eagle at various stages of growth, one of which is here reproduced.

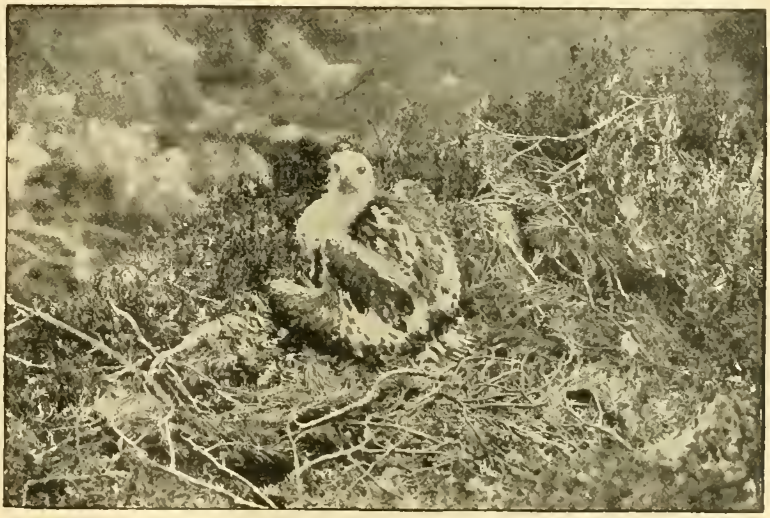


FIG. 1.—Golden Eagle six weeks old. The bird fell from the original eyrie and is here shown in one made by parent birds at the foot of the cliff. From "Birds of the Loch and Mountain."

Mr. Charles Barrett, in "From Range to Sea," covers comparatively new ground, and has attempted to accomplish for some of the birds of Australia what has already been done for those of our own islands. It must be confessed, however, that the illustrations in his booklet (whether from the fault of the photographs themselves, of the reproductions, or of the printer we cannot say) are by no means up to the level of those in some books of English bird-life. In the tiny and exquisitely built nests of such species as the rufous and the white-shafted fantail, with the parent-bird in attendance, the author has subjects quite different from any met with in this country, and in portraying these novelties he appears to have availed himself to the full of his opportunities. The nest of the lyre-bird forms, perhaps, a still more striking subject, which was the scene of an altogether unexpected incident. "On inserting my hand in the nest," writes the author, "a piercing cry, like the whistle of a steam-engine, rang down the gully. It was difficult to realise that the half-fledged lyre-bird which I could feel inside the nest was the cause of this unearthly clamour."

The present booklet is an excellent beginning in Australian bird-photography, and we shall look in the future for more work in the same style from the author and his artist, Mr. Mattingley.

The book standing third on our list is of a somewhat different type from either of the two already noticed, presenting in some degree an approximation to a popular history of South African birds generally. It may serve, in fact, as a kind of popular representative of the volumes on birds in the "Fauna of South Africa," and should be of the greatest value to a large number of persons who for one reason or another are unable to refer to the latter. Indeed, by means of the numerous excellent photographs with which it is illustrated, this volume will enable the sportsman and amateur naturalist in South Africa to determine without any great difficulty a very considerable proportion of the birds with which he may be brought in contact. The illustrations (of which a sample is reproduced) are for the most part excellent, while the text contains a sufficient amount of anecdote and local colouring to redeem it from the charge of dulness.

Personally we have found special interest in the author's account of the eggs and parasitic habits of the honey-guides and cuckoos. Honey-guides, it appears, actually storm the breeding-holes of the species upon which they are parasitic, as was witnessed by the author in the case of a pair of barbets, which offered a fierce resistance to the intruder. As regards cuckoos, it is absolutely certain that in South Africa these birds must generally lay their eggs on the ground and transport them in their beaks to the foreign nests, which they are too large to enter. All the African cuckoos normally lay coloured eggs, but when they lay in nests of species with white eggs, their own eggs are also often white. In the case of the golden cuckoo the author states that "a pure white egg was taken from the oviduct of a female

[1] "Birds of the Loch and Mountain." By Seton P. Gordon. Pp. xvi + 181; illustrated. (London: Cassell and Co., Ltd., 1907.) Price 7s. 6d. net.

"From Range to Sea; a Bird-lover's Ways." By C. Barrett. Pp. 62; illustrated. (Melbourne: T. C. Lothian, 1907.) Price 1s.

"Sketches of South African Bird-life." By A. Haagner and R. H. Ivy. Pp. xxiv+181; illustrated. (London: R. H. Porter, 1908.) Price 20s. net.

shot at the Crocodile River; a white egg was also found in the nest of a Cape wagtail, which was allowed to hatch to make identity certain; further, we took a white egg from the nest of the little red-vented tit-babbler. . . . The usual host is the Cape sparrow, both of us having taken the cuckoo's eggs—coloured like those of the sparrow—from the nests of this bird." Unfortunately, there is no information as to whether there are "white-egged" and "coloured-egged" strains of cuckoos in Africa, or whether the same bird may lay white or coloured eggs according to circumstances.

FIG. 2.—Black-shouldered Kite. From "Sketches of South African Bird-life."

The book is a welcome addition to South African ornithological literature.

## *THE ROYAL SOCIETY'S CONVERSAZIONE.*

THE first of the two conversaziones given annually by the Royal Society was held at Burlington House on Wednesday of last week, May 13. The guests were received by Lord Rayleigh, president of the society, and included leading representatives of many branches of intellectual activity. There were a large number of exhibits, illustrating methods and results of recent scientific work, and in the course of the evening demonstrations were given in the meeting room by Mr. C. V. Boys, F.R.S., on the dynamics of the game of diabolo, Mr. Francis Fox, on the operations involved in the saving of Winchester Cathedral and other ancient buildings, and Mr. C. Gordon Hewitt, on the natural history of the house-fly. Following our usual practice, we give a summary, with a few additions, of the descriptive catalogue of exhibits, and so far as possible have grouped together the exhibits referring to related subjects.

*The British Contribution to the International Investigation of the Upper Air*, 1907–8: The investigation of the upper air under the auspices of the "Commission internationale d'Aérostation scientifique" is now fully organised. This country has taken part in the work unofficially since 1902, and officially since 1904. The investigation as carried on in this country is three-fold. The first part consists in measurements of temperature, humidity, and wind velocity at different levels up to about 10,000 feet, by meteorographs raised by kites. For the second part, automatic traces of the relation between pressure (height) and temperature are obtained by means of meteorographs borne by unmanned balloons (*ballons-sondes*). The balloons are arranged to reach heights up to 22 kilometres in about two hours, and then to burst and descend. The finder is invited to return the instruments and claim a reward. For the third part, the bearing and elevation of small pilot balloons are observed at measured intervals of time by one or two theodolites, and the motion of air currents at different levels is computed from the observations. The exhibits were by Dr. W. N. Shaw, F.R.S., Mr. J. E. Petavel, F.R.S., and Mr. W. A. Harwood, Mr. C. J. P. Cave, Captain C. H. Ley, Mr. Eric S. Bruce, and the Director-General of the Survey Department, Egypt; they illustrated the methods referred to and the results obtained by British investigators.

*The Astronomer Royal:* (1) Photograph on which the new eighth satellite of Jupiter was discovered by Mr. P. Melotte, showing also the sixth and seventh satellites, and photograph of the ninth satellite of Saturn (Phœbe); (2) diagrams of positions of Jupiter's and Saturn's distant satellites, from photographs taken at the Royal Observatory, Greenwich, with the 30-inch reflector; (3) drawings of the solar corona at the eclipses of 1898, 1900, 1901, and 1905, made by Mr. W. H. Wesley from the original negatives; (4) eclipse of 1901, May 18, from photographs taken in Mauritius, and eclipse of 1905, August 30, from photographs taken at Sfax, Tunisia.—*Solar Physics Observatory, South Kensington:* (1) Enlarged photographs of stellar spectra; (2) spectrum of a sun-spot; (3) spectroheliograph disc photographs, taken in "K" light; (4) photographs of prominences, taken in "K" light; (5) photograph of Aberdeenshire stone circle with Cornish circle for comparison.—*Mr. J. Franklin-Adams:* (1) Machine for counting stars upon the 15 inch by 15 inch plates of the Franklin-Adams chart. As the number of stars upon this chart is estimated at 23,000,000, only special areas—selected by Prof. Kapteyn, of Gröningen—will in the first instance be counted. This machine, by Troughton and Simms, is designed to work with such accuracy that regions adjacent to the selected areas may afterwards be added without omissions or overlappings. (2) Machine for drawing precession lines upon the plates of the Franklin-Adams chart. This machine has been designed to draw to a hundredth of a millimetre, if necessary, precession lines giving star places at epochs 1855, 1875, 1900, and 1925, both in Right Ascension and Declination.

*Mr. J. S. Wilson and Mr. W. Gore:* India-rubber models and apparatus used for the investigation of the distribution of stress in dams (Fig. 1). The model, which rests on the top of the trestle, consists of a slab of india-rubber cut to represent the section of a masonry dam, together with its foundation and substratum. The water pressure against the dam is reproduced by plates pulled against the upstream face of the model by cords passing over pulleys and attached to weights. The correct ratio between the density of the fluid represented by that pressure and the density of the masonry (1 : 2·25) is maintained by suspending a large number of weights from pins passing through the model at uniformly distributed points. To obtain strains large enough to measure, both densities are magnified forty times. Photographs are taken of the model and the system of lines ruled on it, one when unstrained and the other when strained by the various forces. The strains are determined by measuring corresponding lengths and angles on the two photographic negatives by means of the optical projection micrometers which are exhibited. The stresses are calculated from the measured strains by the equations relating them, which have been experimentally verified.

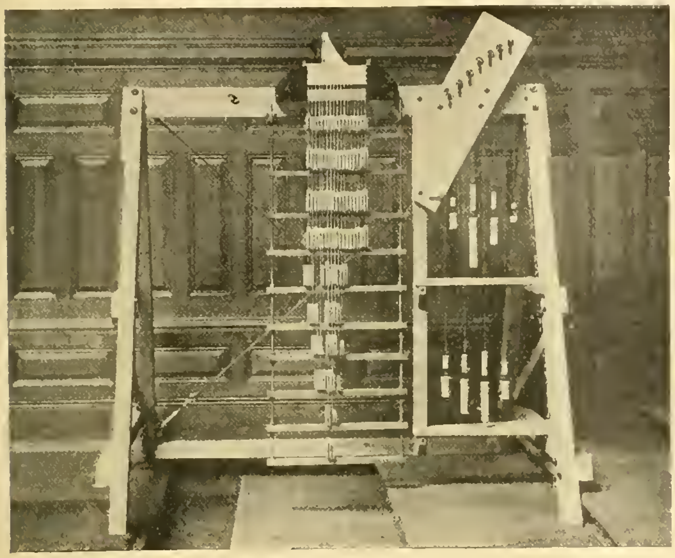


FIG. 1.—India-rubber model and apparatus used for investigations of distribution of stress in dams.

*Sir John Thornycroft, F.R.S.:* An instrument to indicate the relative rate of turning of two bodies. A sphere supported on two equal revolving cylinders rotates on axes in the same plane as the axes of the cylinders; the angular position of the axis of the sphere depends on the relative velocities of the two cylinders, and is indicated by a hand controlled by a roller touching the sphere.—*Mr. C. V. Boys, F.R.S.:* (1) A modification of the well-known hypocycloidal straight line motion of very simple construction, and requiring guides only $2\sqrt{2}$ (0·6 nearly) inch long for a 4-inch stroke. (2) An artificial horizon in which the mercury is spread out into a very thin film on a surface which it does not wet, its edge being held by deeper mercury in a peripheral trough. The film is adjusted in thickness by means of a floating plunger actuated by a screw. Ripples set up by vibration die out almost instantaneously, and altitudes of stars may be taken in towns where with deeper mercury that would be impossible. The mercury is not contaminated by its dry supporting surface. —*Mr. H. G. King and Mr. R. Kerr:* "Master gauges" or "standards" for extremely accurate measurements, the invention of Mr. C. E. Johansson, of Sweden. By using these gauges separately or combined together, more than 80,000 different sizes can be obtained, any of which sizes are accurate to within 0·00004 inch at 66° F. The steel is so treated as to reduce to a minimum any chance of change after being hardened.—*Prof. H. L. Callendar, F.R.S., and Prof. W. E. Dalby:* Apparatus for measuring temperatures in the cylinder of a gas engine.—*Mr. Joseph Goold:* A uniformly symmetrical twin-elliptic pendulum. As the deflector consists of a pair of cross-bars, its mass can be virtually elongated by fixing the bars at any other than a right angle. By this means any rate of change of phase is easily secured. The resulting figures are made available for stereoscopic effects by taking two similar figures and inverting one of them, so that each half figure becomes associated (in the stereoscope) with the complementary half of the other figure.—*Mr. Charles E. Benham:* Stereoscopic effect of twin-elliptic figures.

*Cambridge Scientific Instrument Co.:* The Cambridge patent extensometer. No mirrors or microscopes are used for magnifying the movement, but the extension of the test-piece is measured by a micrometer screw and a modified form of contact measurement. The instrument is made in two separate pieces; the lower piece carries the micrometer screw shown in Fig. 2, and the upper piece carries a spring tongue. These are fixed to the test-piece by pressing the conical points of hard steel rods into centre punch marks in the side of the test-piece, these points being mounted in strictly geometric slides. Both the upper and lower pieces are held in the definite positions shown in the illustration. If the test-piece stretches, the upper piece rotates about the conical points in the depressions in the test-piece, and the end of the tongue approaches the point on the micrometer screw head, the upper piece forming a lever. The arms of the lever are such that the part of the tongue opposite the point on the micrometer head moves five times the amount of the extension of the test-piece. By means of an adjustment the ratio of the arms of the lever can be adjusted so that this multiplication of the extension can be made exact. One arm of the lever is the flexible steel tongue which carries a hardened steel knife-edge near its outer end. If the tongue is bent sideways the knife-edge is moved across the hard steel point, which is carried from the centre of the divided head. To adjust the instrument the screw is turned and the point advanced until contact is made. Relative movement of the lower piece carrying the micrometer screw and the tongue is thus measured, and is proportional to the extension of the test-piece. It can, however, be adjusted more accurately by causing the spring to vibrate and noting the sound caused by it touching the point each time it passes over it. If the point is advanced by 1/1000 mm. nearer the screw the sound produced by contact as the spring vibrates is louder, and the final adjustment of the micrometer screw can be made quickly and accurately. The micrometer screw has a pitch of $\frac{1}{2}$ mm., and the head is divided into 100 parts; each division on the head corresponds to an extension of 1/1000 mm., and as the tenths of divisions can be estimated by eye, readings can be taken to 1/10,000 mm., although it is not claimed that the results are trustworthy to this degree of accuracy.

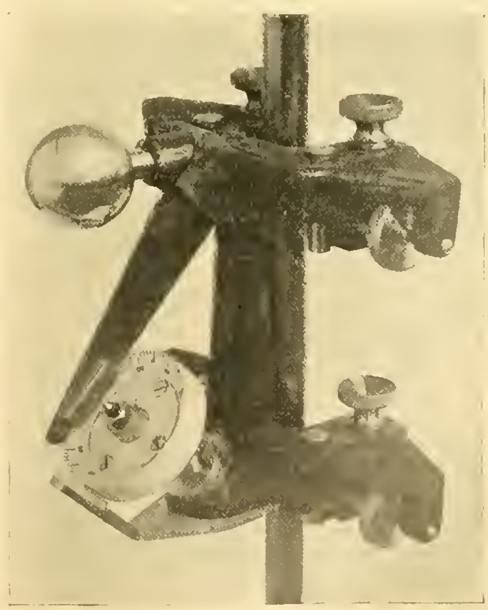


FIG. 2.—Cambridge patent extensometer.

*Mr. J. W. Gordon and Mr. H. Fletcher Moulton:* A new object-glass for high-power magnification. The objective exhibited, used with an ordinary eye-piece, constitutes a high-power ocular capable, in combination with an ordinary high-power objective glass, of yielding a perfect image up to magnifications of eight or ten thousand diameters. Being self-contained, that is to say, independent of external influences, it can be used in any position, and is therefore as well adapted to use with the telescope as with the microscope.

*Mr. J. E. Barnard:* Mercury vapour lamps for microscopic illumination. Mercury vapour lamps have considerable advantages as illuminants for microscopic work, as their visible spectrum consists chiefly of three bright lines, one each in the orange, green, and blue-violet. It is therefore possible, by using suitable absorbent colour screens, to transmit only one bright line of the required colour, the remaining ones being absorbed. The source of light then becomes truly monochromatic, and is practically of one wave-length.—*Mr. Conrad Beck:* (1) Diffraction patterns (antipoints) of point source of light viewed under the microscope with apertures of different shapes illustrating the influence of the aperture shape on microscopic resolution; (2) living bacteria, shown on a dark ground with 1/12 oil immersion lens visible by their own reflected light.

*Prof. T. Turner:* Transparent films of silver and other metals. Gold leaf supported on a glass plate and heated to about 550° C. loses its green colour and transmits white light. Silver leaf heated in air or oxygen to 400° C. becomes remarkably transparent, transmitting white light. The action begins at about 250° C. Copper leaf remains opaque if heated in a reducing atmosphere to 500° C. When heated in air for about an hour to 250°, or for a much shorter time to higher temperatures, the copper becomes transparent and transmits a brilliant green light. This colour continuously darkens with further heating. Aluminium leaf does not become transparent either in an oxidising or reducing atmosphere. Dutch metal skeletonises, but remains opaque.—*Mr. S. D. Chalmers:* Models illustrating refraction at plane and spherical surfaces. These models illustrate the influence of reduced velocity in glass on the form or direction of waves. The curvatures of the incident and refracted waves are indicated by flexible rods; the paths from a point on the incident to the corresponding point on the refracted wave are indicated by cords of constant length.

*Dr. W. J. Russell, F.R.S.:* Pictures showing the action of various coals on photographic plates in the dark. These pictures of different coals were obtained by cutting vertical sections of the coal and laying them on a photographic plate in the dark, at a temperature of about 50° C., for seven to twenty-four hours. The photographic plate was then developed, and the picture printed in the ordinary way.—*Prof. J. Symington, F.R.S., and Dr. J. C. Rankin:* A series of skiagrams illustrating the development of teeth in man. The skiagrams were taken from one lateral half of a series of skulls aged from birth up to puberty.

*Mr. S. Cowper-Coles:* (1) Specimens of bimetallic parabolic mirrors made by electro-deposition. The parabolic mirrors are composed of bands of yellow and white metal, and are made by a combined process of electro-deposition and spinning. (2) Specimens of pure electrolytic iron. Pure electrolytic iron sheets made direct in one operation by a process of electro-deposition from pig iron or ore without any rolling, with a tensile strength of about thirty tons to the inch; the iron is free from crystalline structure.—*Mr. F. W. Aston:* New dark space in helium. The tube exhibited contained helium at a pressure of about 3 mm. It was provided with aluminium electrodes, the kathode being a large flat plate. A continuous current of low density was passed through. Under these conditions the "Crookes dark space" is ill-defined and filled with a greenish glow, while next to the kathode is seen a narrow region of intense darkness sharply defined. The fall of potential across this "new dark space" appears to be invariably about 30 volts.—*Dr. J. A. Fleming, F.R.S.:* (1) Apparatus for exhibiting photo-electric effects with potassium-sodium alloy. The alloy was enclosed with an insulated platinum plate in an exhausted tube. When the plate and alloy were connected to a galvanometer and the surface of the alloy illuminated by an arc lamp, an E.M.F. of about 0·8 volt was created, and a current produced in the circuit by the light. (2) Oscillation valves or glow-lamp electric-wave detectors used for receivers in long-distance wireless telegraphy. It was shown by the exhibitor in 1904 that a carbon filament glow-lamp, having in its bulb a metal cylinder surrounding the filament carried on an insulated terminal, could be used in combination with a galvanometer or telephone as a wave detector in wireless telegraphy, owing to the emission of negative electricity from the incandescent carbon. Such a device was named by him oscillation valve, and is a very sensitive long-distance receiver. Glow-lamp detectors of the type exhibited have been used as receivers in Transatlantic wireless telegraphy, and are also of use as receivers for wireless or radiotelephony. (3) A recent form of cymometer or instrument for measuring the length of the waves radiated by, and the damping of the oscillations in radio-telegraphic antennæ.—*Mr. L. H. Walter:* (1) Tantalum wave-detector for wireless telephony or telegraphy. A tantalum wire point dipping into mercury is spontaneously restoring. At 450 miles, using less than 2 kilowatts, the results equal those of the electrolytic detector. The sound is louder than with the electrolytic when the signals are not too weak. (2) New electrolytic signalling key. A water-cooled signalling key for higher powers (2 kilowatts upwards). A local key circuit actuates two valve electrodes, normally separated, and having the whole primary voltage across them, so that the cell is short-circuited beneath the electrolyte. (3) Model of an experimental form of the exhibitor's magnetic detector of 1906.

*The National Physical Laboratory. Mr. A. Campbell:* (1) Moving-coil vibration galvanometer. This instrument belongs to the class of tuned galvanometers first introduced by Prof. M. Wien. Its novelty consists in the use of the moving-coil system. (2) Variable mutual inductance standard. Designed for the measurement of small inductances and capacities. (3) Standard of mutual inductance calculable from the dimensions. A small model of the large mutual inductance (10 millihenries) recently completed at the National Physical Laboratory. (4) Secondary standard of mutual inductance (subdivided). *Mr. W. Rosenhain:* (5) Quenching apparatus for metallographic specimens, for quenching small specimens of metal *in vacuo* without removing them from the furnace. *Mr. W. Rosenhain, Mr. F. C. A. H. Lantsberry, and Mr. P. A. Tucker:* (6) Composite photomicrographs representing relatively large areas of steel. *Mr. W. Rosenhain:* (7) Tensile fracture of steel under the Zeiss stereoscopic microscope.—*Rev. F. J. Jervis-Smith, F.R.S.:* Apparatus for generating a luminous glow in an exhausted vessel, moving in an electrostatic field, and exhibiting the action of a magnetic field on the glow so produced (see p. 70).—*Mr. J. T. Irwin:* Hot wire oscillograph.—*Mr. S. G. Brown:* Experiments with a high-frequency alternator.

*Mr. R. Threlfall, F.R.S.:* Laboratory apparatus for experiments under very high measured pressures and at very high temperatures—pressures up to 100 tons per square inch, temperatures up to 2000° C. Advantage is taken of the practically perfect fluidity of crystalline graphite at high pressures, and of the solidity of compressed magnesia, zirconia, &c., to construct an apparatus on the laboratory scale for such experiments as the possible transformations of carbon under high temperatures and pressures.—*Prof. T. B. Wood:* The factors which influence the baking value of wheat flour. The "strength" or baking value of wheat is determined by two main factors:—(1) high diastatic capacity, which continuously produces sugar in the dough, and thereby enables the yeast to keep up a continuous evolution of carbon dioxide; (2) suitable concentration of acid and salts in the flour, which affects the physical properties of the gluten, and hence the shape of the loaf. —*Dr. T. E. Thorpe, F.R.S.:* (1) Apparatus and specimens used in connection with the determination of the atomic weight of radium; (2) glass and quartz vessels coloured under the influence of radium.—*Sir William Crookes, F.R.S.:* Scandium, its salts, and its position in the scheme of the chemical elements. Scandium is an exceedingly rare terrestrial element, occurring in very few minerals and in very small amount—usually not more than 0·01 per cent. The one exception is the rare mineral wiikite, which contains scandium in considerable quantity. Astronomical research has demonstrated the presence of scandium in comparative abundance in the sun and some of the brighter stars. To enable its spectrum lines to be identified with certainty, especially in some of the fainter celestial bodies, a thorough examination of its spectrum has been undertaken.—*Messrs. Johnson, Matthey and Co., Ltd.*: (1) Apparatus in transparent fused silica; (2) various vessels of pure iridium.

*Miss Amy Barrington and Prof. Karl Pearson, F.R.S.*: Specimens of the hair of chestnut horses. Samples of hair from the ribs, mane, and tail of chestnut horses to show:—(1) the wide range of chestnut coats; (2) that "chestnut" is not a simple unit character; and (3) that the mane and tail of chestnuts can be sensibly black.—*Marine Biological Association of the United Kingdom*: (1) Living representatives of the Plymouth marine fauna; (2) photographs illustrating methods of dredging and trawling (North Sea investigations).—*The Grouse Disease Commissioners*: Specimens illustrating certain aspects of the work of the Grouse Disease Committee, 1905–8. A committee of inquiry into the causes of disease in the red grouse (*Lagopus scoticus*) was constituted in 1904 at the suggestion and under the chairmanship of Lord Lovat; the work and results, of which the exhibit represented a part, will be published by the Zoological Society of London.—*Mr. C. Gordon Hewitt*: The large larch saw-fly (*Nematus erichsonii*, Hartig). The larch saw-fly has increased during the last few years to so great an extent in many of the large larch plantations in Cumberland as to become a serious pest. Many hundreds of acres of larches were completely defoliated in 1907. Except in the young plantations, it will be necessary to rely on natural means of control, of which birds and voles are at present the most important.—*Mr. F. Enock*: Living specimens of Mymaridæ-ovivorous parasites (new to Great Britain).

*Prof. R. T. Hewlett and Mr. J. E. Barnard*: A method of disintegrating bacterial and other cells. The machine consists of a phosphor-bronze vessel, revolving at a high speed, containing hardened steel balls, which are kept in position at the periphery of the vessel by a central steel cone. By retarding the revolution of the central cone, a drag is put on the balls, so that a grinding action takes place between them and the internal surface of the vessel. Rise of temperature is prevented by the use of liquid carbonic acid or other means.—*Dr. Ernest F. Bashford, for the Executive Committee, Imperial Cancer Research Fund*: Cancer as a manifestation of cell-life throughout the vertebrates, and the biological properties of cells which have become cancerous.—*Prof. W. B. Bottomley*: Bacterial treatment of non-leguminous plants. (1) Specimens showing effect of nitrogen-fixing organisms upon growth of oats, barley, turnips, radishes, tomatoes, &c.; (2) cultures and microscopical preparations of nitrogen-fixing bacteria (*Pseudomonas radicicola, Azotobacter beyerinckii*, &c.).

*Prof. J. Milne, F.R.S.*: Seismograms recorded by a Milne seismograph in the Isle of Wight. (1) These seismograms illustrate the difference in character of records obtained from the same instrument. The Mexican earthquake of March 26, 1908, was obtained on *quickly* running paper. The earthquakes of August 9, 1901, were obtained on *slowly* moving paper. In the former halation effects do not eclipse the first preliminary tremors, and an open diagram is obtained. (2) The three earthquakes which occurred on August 9, 1901, indicate the value of seismograms in correcting cablegrams. The interval of time between the preliminary tremors and the maximum motion shows that the origins of the first and third disturbances were 6000 miles distant, while the second was nearly 7000 miles distant. The first and last came from Japan, while the second came from the East Indies. In American and European newspapers it seems to have been universally stated that the origins were in Alaska.—*Dr. C. W. Andrews, F.R.S.*: Restored model of the skull and mandible of *Prozeuglodon atrox*. *Prozeuglodon atrox* is a primitive whale (Zeuglodont), and is one of the forms which unite the true Zeuglodonts with the early land-carnivores known as Creodonts.—*Mr. J. Y. Buchanan, F.R.S.*: Features of land-ice illustrated by photographs and stereoscopic slides in the taxiphote. These slides, taken last winter in the grotto of the Morteratsch glacier, illustrate the internal structure of the ice in winter.—*Mr. A. Hutchinson*: Protractors for constructing stereographic and gnomonic projections of the sphere. The protractors exhibited are intended for the use of students of crystallography, and are designed to facilitate the construction of great and small circles in the stereographic projection.

*Mr. Henry Balfour*: Stone implements of very early date from the Zambezi River and some of its tributaries. A large proportion of the implements of chalcedony, quartzite, &c., are of forms exactly similar to types characteristic of the river-drift period of western Europe and Great Britain. These were found associated with, and evidently forming part of, ancient terrace gravels deposited as drifts by the Zambezi at a remote period. Several implements were found by excavation in undisturbed gravel deposits at depths varying from 6 inches to 2 feet.—*Prof. W. M. Flinders Petrie, F.R.S.*: Drawings of ancient zodiacs.—*Prof. W. Gowland, F.R.S.*: Megalithic monuments in Japan (see NATURE, February 14, 1907, vol. lxxv., p. 382).—*Mr. Francis Fox*: The saving of Winchester Cathedral and other ancient buildings. (1) Specimens of the beechwood logs on which the cathedral stands; (2) block of the peat found beneath the walls, in some cases 8 feet in thickness; (3) sample of the gravel bed down to which the underpinning is carried by a diver; (4) old box-wood rule found during the operations.—*Mr. J. Gray*: An instrument for measuring the colour of the hair, eyes, and skin (NATURE, February 27, vol. lxxvii., p. 406).

*Prof. Silvanus P. Thompson, F.R.S.*: Drawings of early compass cards and windroses. The compass card was developed from windroses drawn on the Portulani, or sailing charts, at the points of intersection of the loxodromic lines. The drawings shown were from old Portulani or other early works dating from 1375 to 1584.—*Messrs. T. and R. Annan and Sons*: Photographs of Lord Kelvin.—*Mr. J. Stewart, Largs*: Photographs of Lord Kelvin, and relating to him.

*Prof. A. H. Church, F.R.S.*: Documents and specimens of historical interest referring to the Royal Society, including an unpublished letter of Captain James Cook, F.R.S., the circumnavigator, dated Rio de Janeiro, September 30, 1768, and seventeen portrait medals, struck at the Paris mint, of foreigners who were members of the Royal Society.

*Messrs. B. J. Hall and Co., Ltd.*: Ordoverax copying process. This process is one for rapidly and accurately producing facsimile copies of line drawings and tracings on any materials. The original is first copied on ferro-prussiate paper; the copy is placed before development, face downwards, on a plate of ordoverax composition previously prepared. The portions of the ferro-prussiate paper not affected by light act upon the ordoverax composition, causing it to take up printers' ink from a roller, whereas the parts of the plate not so acted upon do not take up any ink.—*Mr. Donald Cameron-Swan*: A new method of reproducing pencil and other drawings. This method (which is being employed for the Memoirs of the National Antarctic Expedition) differs from most photo-mechanical processes of reproduction in that the drawings are reproduced in exact facsimile, without any background of tone where none exists in the originals.

## NOTES.

THE British associates and correspondants of the Institute of France will attend at St. James's Palace on Wednesday next, May 27, at 11 a.m., to present an address to the President of the French Republic on the occasion of his visit to this country.

THE Royal Society of London invites applications for two Mackinnon research studentships, each of the annual value of 150*l*. These studentships, which are restricted to British subjects, are offered for the purpose of researches in physical and biological sciences, one being awarded for research in the group of the physical sciences, including astronomy, chemistry, geology, mineralogy, and physics, the other for research in the group of the biological sciences, including anatomy, botany, palæontology, pathology, physiology, and zoology. Applications must be sent in to the Royal Society not later than June 10 on forms which can be obtained from the assistant secretary of the Royal Society, Burlington House, W.

ON July 1 the president and council of the Linnean Society will entertain the Darwin-Wallace medallists and foreign guests to dinner at Prince's Restaurant.

PROF. OTTO BÜTSCHLI, of Heidelberg, and Prof. A. G. Nathorst, of the Naturhistoriska Riksmuseum, Stockholm, have been elected foreign members of the Linnean Society.

THE annual visitation of the Royal Observatory, Greenwich, by the Board of Visitors will be held on Wednesday, June 3. The observatory will be open for inspection by guests at 3 p.m.

THIS year's meeting of the French Association for the Advancement of Science will be held at the beginning of August at Clermont-Ferrand. Sir William Ramsay, K.C.B., F.R.S., has accepted an invitation to lecture during the meeting on his researches. Full particulars of the proceedings at Clermont-Ferrand can be obtained from the offices of the French Association, 28 rue Serpente, Paris.

ON Tuesday next, May 26, Prof. W. Stirling will begin a course of two lectures at the Royal Institution on "Animal Heat and Allied Phenomena." The Friday evening discourse on May 29 will be delivered by Sir Ralph Payne-Gallwey on "Ancient and Mediæval Projectile Weapons other than Firearms," and on June 5 by Sir James Dewar on "The Nadir of Temperature and Allied Phenomena."

THE first International Congress of the Cold Storage Industries is to be held in Paris, at the Grand-Palais, at the end of September next. One of the sections, of which M. d'Arsonval is the president, will concern itself with questions relating to low temperatures and their general effects. We understand that Sir James Dewar, Sir William Ramsay, and MM. Van der Waals, Kamerlingh Onnes, Linde, Georges Claude, and Jean Becquerel will be among the contributors to this section.

THE Berlin correspondent of the *Times* states that a scientific expedition to the South Seas left Hamburg on May 16 on board the steamship *Peiho*, a vessel of 900 tons, which has been specially chartered for the cruise from the Hamburg-American Line. The expedition has been organised by the trustees of the scientific foundations of the city of Hamburg, and its mission is to complete the exploration more particularly of the German islands in the South Seas and to collect materials for the study of the natives and natural resources of those regions. Dr. F. G. H. H. Fülleborn, assistant at the Hamburg Institute for Tropical Diseases, is in charge of the expedition, and he is accompanied by a competent staff of assistants.

THE Home Secretary has appointed a committee on the use of lead in the manufacture of earthenware and china. The committee includes, with others, Mr. E. F. G. Hatch (chairman), Mr. A. Vernon Harcourt, F.R.S., Dr. George Reid, Mr. William Burton, and Mr. Bernard Moore. The committee is to consider the dangers attendant on the use of lead in pottery, and to report how far these can be obviated or lessened by improved appliances and methods in lead processes, by the limitation of the use of lead, by the substitution of harmless lead compounds for raw lead, by the substitution of other materials for lead, and by other means. The danger or injury to health arising from dust or other causes in the manufacture of pottery, and the special rules regulating the decoration of earthenware and china, are also to be considered.

A CORRESPONDENT writes:—"The Atlantic Ocean is in certain parts about four miles deep. Would a rock, if thrown into the ocean at its greatest depth, sink to the bottom?" The inquiry is a little indefinite, but Dr. C. Chree, F.R.S., has been good enough to send us a reply to it, in the course of which he points out that any solid of larger than microscopic dimensions will fall in a liquid with continuously increasing velocity so long as its density exceeds that of the liquid. Even at a depth of four miles the pressure of the water is only about four tons to the square inch, and such increase is quite insufficient to raise the density of water to that of ordinary rock. In the case of some exceptional form of rock, the density of which approaches closely to that of water when both are uncompressed, the result would depend on the relative compressibility of water and the material, combined with any slight effects due to change of temperature.

AT the instance of the late Secretary of State for the Colonies, and with the cooperation of the Government of the Sudan and the Royal Society, the Government has decided to establish in London a bureau for the collection and general distribution of information with regard to sleeping sickness. The Royal Society will find accommodation for the bureau at Burlington House, and one-fourth of the cost of upkeep will be borne by the Sudan Government. The bureau will be under the general control and direction of an honorary committee of management, appointed by and responsible to the Secretary of State for the Colonies. The committee will include the Right Hon. Sir J. West-Ridgeway, G.C.B. (chairman), Sir Patrick Manson, K.C.M.G., F.R.S., Sir Rubert Boyce, F.R.S., Dr. Rose Bradford, F.R.S., and Colonel D. Bruce, C.B., F.R.S. The main function of the bureau, which will be administered by a paid director, will be to collect from all sources information regarding sleeping sickness, to collate, condense, and, where necessary, translate this information, and to distribute it as widely and quickly as possible among those who are engaged in combating the disease. The publications of the bureau will be divided into two categories, viz. scientific publications intended for those who are engaged in research work or in carrying out medical administration in the infected districts, and publications of a less technical character for the use of Government officials, missionaries, and others, whose duties involve residence in those districts. One important piece of work will be the preparation of a map of the whole of tropical Africa, showing the distribution of the disease and of the different species of blood-sucking insects which are suspected of conveying it. The duties of the director of the bureau will for the present be undertaken by Dr. A. G. Bagshawe, of the Uganda Medical Staff, who has been seconded from the Protectorate service for the purpose.

A MEDUSA from Java, referable to the remarkable genus Chiropsalmus, previously known by one species from Brazil and Carolina and a second from the Rangoon coast, is described by Dr. R. Horst as new in Leyden Museum Notes (vol. xxix., No. 2) under the name of *Ch. buitendijki*. Unfortunately, the only known example of the Rangoon *Ch. quadrigatus* is in very bad condition, so that the distinctness of the Java form does not appear absolutely beyond doubt.

IN addition to a paper on fossil cetaceans by Mr. True, and one on the meteor-crater of Canyon Diablo by Mr. Merrill, which have been already mentioned in NATURE, the fourth part of vol. iv. of the quarterly issue of Smithsonian Miscellaneous Collections contains an illustrated account, by Mr. R. Arnold, of the shells from the Tertiary oil-bearing strata of Santa Barbara, California.

Students of Coleoptera should be interested in a revision, by Mr. T. L. Casey, of the tenebrionid beetles of the subfamily Coniontinæ, published in the Proceedings of the Washington Academy of Sciences (vol. x., pp. 51–166), where several new generic groups are suggested and named, and also in descriptions, by Mr. W. D. Price, of new weevil-like species of the group Anthonomini, forming No. 1604 of the Proceedings of the U.S. National Museum.

A large portion of part iii. of vol. lxxxix. of the *Zeitschrift fur wissenschaftliche Zoologie* is occupied by a contribution from Mr. Valentin Dogiel, of St. Petersburg University, entitled "Catenata, eine neue Mesozoengruppe." The new group is established for the parasites of the genus Haplozoon, one of which was discovered by the author (as narrated in the *Zoologischer Anzeiger* for 1906) in the intestine of the polychæte worm *Travisia forbesi*, and the other in that of *Clymene lumbricalis*, a second member of the same group. The paper is illustrated by three plates (one partly in colour) showing the structure and development of these remarkable organisms.

In the course of a paper on the nest of the ringed plover, published in the May number of *British Birds*, Mr. W. P. Pycraft argues that the commonly accepted theory as to the nesting of the earliest birds does not accord with the structure of Archæopteryx. Such birds, according to this theory, are believed to have nested in holes in trees, where they laid white eggs. But, urges the author, such a habit would be unsuited to a bird with a long body tail, which, in his opinion, is more likely to have made its nest in some such site as the crown of a tree-fern or a cycad. Is, however, it may be asked, the tail of Archæopteryx likely to have been much more in the way in a nesting-hole than are the tail-feathers of a hornbill?

Now that Lamarck has received the recognition due to a pioneer of the evolution-doctrine, it is interesting to learn of the existence in Harvard University of a holograph manuscript from his pen. This MS., as we gather from a notice contributed by Prof. Bashford Dean to the *American Naturalist* for March, was written some time previous to 1820, and forms a series of essays and drafts of later work, comprising about ninety folios, of which fifty have writing on both sides. It was presented to Harvard by Prof. A. Agassiz, who appears to have obtained it in Paris in 1906. Prof. Dean gives a summary of its chief contents, together with reproductions of pen-and-ink sketches of micro-organisms and of a holothurian by Lamarck himself.

The urgency of legislation for the protection of whales and turtles forms the subject of a forcible article by Dr. G. R. Wieland in the May issue of the *Popular Science Monthly*. The destruction, and in some cases practical extermination, which have resulted from the pursuit of the more valuable species of whales are familiar to all, but it is less well known how serious is the diminution in the number of turtles—edible and otherwise. It is, urges the author in conclusion, "neither Utopian nor impractical to attempt and speedily carry out the measures required for the preservation, not only of land animals, but of all our great animals of the sea. The only element of doubt is whether the volume of sentiment can soon enough make itself felt—in short, whether the race has reached the required culture stage in time."

In the *Philippine Journal of Science* (iii., No. 1), Mr. Y. K. Ohno gives formulæ which express the laws governing agglutination phenomena as regards bacteria and agglutinating sera. The union of agglutinin and agglutinable substance he regards as a chemical reaction, and not as an absorption phenomenon.

In the Scientific Memoirs of the Government of India (No. 31), Capt. Patton, I.M.S., details further observations on the tropical disease, kala azar, and its parasite, the Leishman-Donovan body, which, he finds, undergoes a cycle of development in a bed-bug (*rotundatus*), by the bite of which the disease is presumably communicated.

Opinion has of late been divided as to whether spirochætes belong to the bacteria or to the protozoa. In a paper on the *Spirochaeta pallida* of syphilis, Krzysztalowicz and Siedlecki definitely class these organisms as protozoa belonging to the Mastigophora, and propose to include them in a new family, the Spirilloflagellata (*Bull. Internat. de l'Acad. des Sciences de Cracovie*, No. 3, 1908).

To meet the requirements of students and others with small incomes, Mr. C. Baker, of High Holborn, maintains a department for second-hand scientific instruments. The quarterly list recently issued contains as many as ten different sections. All kinds of microscopes and microscopic requisites, surveying and drawing instruments, also various pieces of optical and physical apparatus can be inspected and purchased under guarantee as to adjustment.

The account of floral development and embryogeny in the wheat plant communicated by Mr. A. H. Dudley to the Liverpool Microscopical Society, and published in its thirty-ninth annual report, presents one or two special points of interest. The author obtains similar results to those recorded by Cannon for the megasporangium of Avena in so far that no parietal cell is cut off from the archesporium, and that numerous antipodal cells are produced in the embryo-sac; the limitation of the suspensor to the primary basal cell and the first divisions in the embryo appear to be similar.

Two circulars referring to the International Botanical Congress that will be held in Brussels two years hence have been received. The first announces that, in place of the late Prof. Errera, Baron de Moreau, formerly Minister of Agriculture, has consented to become a president of the organising committee, sharing that position with Mr. Th. Durand, and that Dr. E. Wildeman will act as general secretary. The constitution of various local subcommittees is also indicated. The second circular gives the names of the two committees appointed for dealing with cryptogamic and palæobotanical nomenclature, and invites expressions of opinion with regard to rules additional to those formulated for phanerogamic plants and generic names that should be maintained in spite of priority rules.

An editorial in the *Indian Forester* (March) referring to education and research in India cites the opinions expressed in Nature of January 2 as to the wisdom of appointing professors and teachers who have shown their ability for prosecuting original research; in this connection, it is urged that the training of Indian foresters should be entrusted to men who have made a special study of forest problems in India. An instructive article on the private and communal forests in Japan is contributed by Sir Frederick Nicholson to contrast conditions with those found in the presidency of Madras. It is estimated that private forests cover 14 million acres, and the communal forests exceed 4 million acres, providing about an acre and a half of woodland for every acre of arable land. Within recent years the necessity for re-planting has been recognised; *Cryptomeria japonica* and other conifers are generally selected, but camphor and chestnut trees are also largely planted; around the fields, mulberry, lacquer, and vegetable-wax trees are grown.

MR. C. F. STRAWSON has issued his ninth annual report on the destruction of charlock in corn crops during 1907 by spraying with a copper sulphate solution. Experiments extending over ten years have shown that young charlock can be destroyed in growing corn crops without injury to the latter by spraying with fifty gallons of 3 per cent. solution of copper sulphate (15 lb. to fifty gallons) per statute acre, and older charlock with a stronger solution. The corn crops are much improved, and give a better yield, where the charlock is destroyed, and young grass seeds and clover in the corn remain uninjured. The object of Mr. Strawson's annual reports is chiefly to induce those who cultivate charlock-seeded soils to adopt this new and easy method of restoring the land to its full crop-producing value.

IN a paper read before the Physiological Society on March 21, Dr. A. D. Waller, F.R.S., demonstrated that the contractility of animal and vegetal nerves observed by Prof. Bose (see NATURE, March 5, supplement, p. iii) may be obtained on fiddle-strings, or any other kind of strings, and is due to heating of the structures by the "fairly strong tetanisation" currents used by Prof. Bose. Dr. Waller calculates that the heat developed by the currents used, in the absence of evaporation, is sufficient to raise the temperature of a nerve 1°·35 per sec. Engelmann in 1895 showed that fiddle-strings in water contracted when heated. With weak tetanisation there is obtained elongation, with strong, shortening. The weight and the electrical conductivity of a fully contracted string are greatly diminished by loss of water.

ONE of the most important agricultural questions in Cape Colony, the deterioration of the veld, is discussed in the March number of the *Agricultural Journal of the Cape of Good Hope*. It seems to be established that the veld will no longer nourish cattle as well as formerly, and five causes are stated to have brought this about:—(1) overstocking and the kraaling of stock; (2) formation of sluits or dongas; (3) spread of noxious weeds; (4) burning of the veld; (5) destruction by drift sands. Overstocking, *i.e.* putting too many cattle on to a given area, is harmful, because the grasses or plants relished by the animals are so completely eaten off that they become exterminated, and their place is taken by plants which the animals have rejected, and which are, therefore, of no agricultural value. Some are positively noxious, *e.g.* the jointed cactus (*Opuntia pusilla*), which is likely to cause considerable trouble in future, the prickly pear, and the Mexican poppy. Kraaling, or herding the animals together at night to protect them from jackals, &c., has the effect of wearing down definite pathways, and thus starting the channels for the flow of water which finally develop into the sluits and dongas so characteristic of the veld. The burning of the veld is responsible for a good deal of damage, since the organic matter is largely destroyed, and there is considerable loss of nitrogen. Nevertheless, some means of removing old dead grass is necessary, for a good deal is apt to be left over from the previous season; sheep will not eat it, and it interferes with the new growth; there seems no option but to burn it. The whole problem is of vital importance, and can only be solved after careful scientific investigation.

THE American Government, in view of the rapid occupation of all the available land in the western States, has started a vast reclamation scheme. The most important is that for the irrigation of what are known as the Great Plains, the region extending from the Missouri River to the foot of the Rocky Mountains and from the Panhandle of Texas northward to the Canadian frontier. The projects now sanctioned in various parts of the country provide for the expenditure up to the year 1911 of about fourteen millions in the reclamation of some two millions of acres. The progress of this great experiment is described in the April number of the *National Geographical Magazine* by Mr. C. J. Blanchard, statistician to the U.S. Reclamation Service, under the title of "Home-making by the Government." The illustrations of fruit and other products grown under irrigation present a vivid picture of the possibilities of this important enterprise. The most remarkable of these projects is the Salt River scheme in Arizona, which involved the construction of the "most wonderful highway ever built by man," that on Fish Creek Hill, where a road has been cut along the banks of a stupendous canyon through the living rock for a distance of forty miles.

THE chain has hitherto received scant attention from investigators in the field of elasticity and strength of materials, and a welcome addition to the two or three scattered memoirs on the theory of the stresses in chain-links is made by a memoir on the strength of chain-links by Prof. G. A. Goodenough and Prof. L. E. Moore, forming Bulletin No. 18 of the University of Illinois Engineering Experiment Station. The investigation described deals with the development of the theory of the stresses induced in chain-links with given conditions as regards loading, with experimental tests of the validity of the theory employed, and with the assumptions made as to the distribution of pressure between adjacent links, and the deduction from theoretical considerations alone of rational formulæ for the loading of chains. Experiments made on steel rings were found to confirm the theoretical analysis employed in the calculation of stresses. Experiments on various chain-links further confirm this analysis. The introduction of a stud in the link equalises the stresses throughout the link, reduces the maximum tensile stresses about 20 per cent., and reduces the excessive compressive stress at the end of the link about 50 per cent. The following formulæ are applicable to chains of the usual form:—$P=0\cdot4\ d^2S$ for open links, and $P=0\cdot5\ d^2S$ for stud links, where $P$ denotes the safe load, $d$ the diameter of the stock, and $S$ the maximum permissible tensile stress.

THE report of the Meteorological Service of Canada for the year 1905 has recently come to hand; it consists of xix+418 quarto pages, nearly all of which are taken up with monthly and annual summaries, including hourly or bi-hourly observations of air-pressure and temperature at some of the first-order stations. The careful preparation of these voluminous tables is of itself a stupendous undertaking; among the extreme shade temperatures we note 104°·5 at Spence's Bridge (British Columbia) in July, and −53°·0 at two stations in Alberta in February. The percentage of fulfilment of weather forecasts is very satisfactory, the average for all districts being 85·1; the greatest annual success is 86·9, in the Upper St. Lawrence district. In an interesting supplement Prof. W. J. Loudon discusses the effect of different winds on the "seiches" observed, and also gives the results of his researches in atmospheric electricity, at High Rock station, Georgian Bay.

IN the *Physikalische Zeitschrift* for May 1 Dr. L. Mandelstam considers the question whether the usual method of representing dispersion on the electromagnetic theory, as due to the presence in the medium of electrical resonators, is capable also of explaining the gradual extinction found to take place as due to radiation from the resonators. He comes to the conclusion that it is not, and in this respect is in opposition to Prof. Planck, to whom the theory of dispersion owes so much.

THE concluding fascicule of the *Bulletin des Séances* of the Société française de Physique for the year 1907, which has just been issued, contains a valuable *résumé* of the communications made to the society during the past year. It occupies eighty pages, and is of the greatest service to those who have not the time to read the complete papers. A glance at the titles of the abstracts is sufficient to show that the Société française de Physique maintains its position as one of the most successful of the societies which receives and publishes original work done in the field of physics.

MANY geographical works, offered at greatly reduced prices, are included in a catalogue of publishers' remainders just issued by Mr. H. J. Glaisher, Wigmore Street, London, W.

AN admirable summary of the mineral resources of Western Australia is given by the Agent-General, the Hon. C. H. Rason, in the May number of the *Empire Review*. The twenty-three years' mining history of the colony proves it to be one of the richest mineral territories in the world.

AN illustrated itinerary of pleasure cruises to the Norwegian fiords by the yachting steamer *Midnight Sun* has been received from the Albion Steamship Co., Ltd., Newcastle-upon-Tyne. Each cruise extends over fourteen days, and the minimum fare is ten guineas. The sailings commence on June 6.

A USEFUL catalogue of electrical measuring instruments for technical and laboratory purposes has just been issued by Messrs. Isenthal and Co., Mortimer Street, London, W. Particulars and illustrations are given of electromagnetic, moving-coil, hot-wire, and switchboard instruments of special types, and also of aperiodic precision instruments on the dynamometer principle, and insulation testers. The catalogue makes the selection of a suitable instrument of any of these designs a simple matter.

MESSRS. MARION AND CO., LTD., of Soho Square, London, announce a prize competition in which money prizes are offered for photographic work done on their plates, films, and printing papers during the present season. Of the four classes into which the competition is divided, one is for photographs of scientific interest. Biological, geological, astronomical, and natural history photographs, spectroscopic work, and photomicrography serve to indicate the general character of this class, though other scientific subjects are eligible. The first, second, and third prizes in this class are, respectively, 10*l*., 5*l*., and 2*l*., and Mr. Chapman Jones will be the judge.

THE recent removal of Swedenborg's body from London to Stockholm, after it had reposed in the Swedish Lutheran Church in London for one hundred and thirty-six years, is a part of a larger movement for the recognition of the genius of Swedenborg in the domain of science. The movement began outside Sweden. Dr. Max Neuberger, of Vienna, in 1901 delivered an address before the assembly of German Naturalists and Physicians entitled "Swedenborg's References to the Physiology of the Brain." Following up this interest, Dr. Neuberger addressed a communication to the Academy of Sciences of Stockholm in which he expressed his regret that Swedenborg's extensive manuscript on the brain, which is preserved in the library of the Academy of Sciences, had not yet been published. This led to the appointment of a committee to investigate the matter. Prof. Gustaf Retzius, the chairman of the committee and president of the academy, made a study of the subject of Swedenborg's physiological treatises. He became so impressed with the value of these works that he proposed to the academy to issue an edition of Swedenborg's scientific and philosophical works, and offered to bear the expense of the first three volumes himself. Several volumes of these and other of Swedenborg's works have already been published. The examination of Swedenborg's manuscripts is leading to the conclusion that theories and facts in many branches of science usually assigned to much later dates and to other men of science are becoming recognised as largely the work of Swedenborg.

## OUR ASTRONOMICAL COLUMN.

A BRILLIANT METEOR.—A meteor of extraordinary brightness was seen by several observers at 9.45 on Sunday evening, May 17. Mr. T. F. Connolly, of the Solar Physics Observatory, observed the object from Wimbledon Common. It apparently commenced its flight about half a degree east of Polaris, and, travelling slowly to the east of north, passed about half-way between $\delta$ and $\gamma$ Cassiopeiæ. The brightness of the meteor exceeded that of Venus, which was above the horizon, and the head was pear-shaped. The duration of the flight was between three and four seconds; no trail was observed, and the meteor disappeared when at some twelve degrees above the horizon. This object was independently observed by Mr. H. E. Goodson, who states that it was one of the brightest he has ever seen. Mr. P. W. Copeland also writes to say that he observed the meteor at Belper, Derby, at the same time. He says:—"The meteor was of the slow-moving type, and I estimated its apparent diameter as from two to three times that of Venus at the present time. Just before the end of its path, a smaller portion, apparently at a lower temperature, separated and dropped in a more vertical direction. This observation has been confirmed by a friend who saw the meteor at Derby, eight miles from Belper."

CORRELATION OF STELLAR CHARACTERS.—A second paper by Miss Gibson and Prof. Karl Pearson on the correlation of stellar characters appears in the Monthly Notices (R.A.S.) for May (vol. lxviii., No. 5, p. 415). The characters of which the correlations have been examined in this paper are magnitude, colour, spectral class, proper motion, parallax, and position, all of which are of fundamental importance in any study of cosmical structure. As might be expected, there is found to be a marked relationship between the colours and the spectral classes of the stars considered, whilst the relation between magnitude and spectral class is but about half so marked; the latter is sensibly increased if the temperature classification of Sir Norman Lockyer be taken as the index of spectral class. The type of spectrum is also shown to be definitely associated with proper motion and parallax. It follows that, judging from the Yale parallax stars considered, there is a sensible correlation between chemical constitution and motion in space. Among the numerous other results obtained by Prof. Pearson we may mention that he confirms Prof. Newcomb's deduction that the mean parallax of an array of stars of given proper motion is one-fifteenth of that proper motion.

VARIABLE STAR WORK AT THE LAWS OBSERVATORY, MISSOURI.—Bulletin No. 13 of the Laws Observatory, University of Missouri, contains brief descriptions of the Zöllner-Müller photometer and the Gans-Crawford telescope recently acquired by the observatory for use in the series of photometric observations being carried out there. The results of numerous observations and revised elements and light-curves are also published for the variable stars X and V Lacertæ. Bulletin No. 14, from the same source, discusses 160 observations of the peculiar variable RV Tauri (45, 1905). The light-curve of this object is of the $\beta$ Lyræ type, and the maxima and secondary minima present variations in amplitude which appear to be irregular. Between November, 1904, and July, 1905, the character of the variation seems to have altered completely, while further observations made at the Laws Observatory during 1906 and 1907 indicate that the curve has again changed its form. This object then presents an unsolved problem similar to that presented in the cases of R Sagittæ and V Vulpeculæ.

PHOTOMETRIC OBSERVATIONS OF SHORT-PERIOD VARIABLE STARS.—No. 4247 of the *Astronomische Nachrichten* (p. 369, May 8) contains a series of results of the observations of twenty-nine variable stars of short period obtained by Herr H. v. Zeipel at the Upsala Observatory during 1907. For each star two comparison stars were employed, and their positions and magnitudes are given at the head of each table.

THE RELATIVE ACCURACY OF VARIOUS DOUBLE-STAR OBSERVERS.—A short paper by Herr V. Ehrenfeucht, appearing in No. 4247 of the *Astronomische Nachrichten* (p. 381, May 8), deals with the relative accuracy of the principal double-star observers. The resulting figures were obtained by comparing the measures of these observers with the ephemerides of fifty-two well-known doubles, and the probable errors in position-angle and distance are given for eleven observers. The errors in distance range from $0''.055$, for Schiaparelli, to $0''.100$, for Mädler, the mean value for all the observers considered being $0''.698$.

ITALIAN OBSERVATIONS OF THE SUN DURING 1907.—The usual summary, by Prof. Riccò, of the observations of spots, faculæ, and prominences made at Catania during last year, appears in No. 3, vol. xxxvii., of the *Memorie della Societa degli Spettroscopisti Italiani*.

The present paper deals especially with the second semestre of 1907, but the values for the whole year are given. For the period July to December the mean daily frequencies of spots, faculæ, and prominences were 5·7, 2·1, and 4·7 respectively, whilst for the whole year the corresponding values were 5·5, 3·4, and 4·3.

THE NATAL OBSERVATORY.—Mr. Nevill's report of the work done at the Natal Observatory during 1907 is, as usual, chiefly devoted to the meteorological results obtained at the various meteorological stations of the colony. The only astronomical note of general interest is that a series of observations of comet 1907*d* was made by Mr. A. E. Hodgson, and the results are to be communicated to the Royal Astronomical Society. The magnetic declination at Durban for January 1, 1908, is given as $22^{\circ} 27'$ W., with a yearly decrease of $12'$, and the present value of the dip is $63^{\circ}.2$.

SOLAR PHENOMENA AND TERRESTRIAL TEMPERATURES.—In a paper published in the *Bulletin de la Société astronomique de France* for May, Dr. J. Loisel discusses the relationships between the activity of various solar phenomena and the amount of heat received at the earth's surface. The results are based on the observations made at Montpellier during the period 1883–1901, and are of such interest as to suggest the desirability of prosecuting this research in many more different localities. Plotting the actinometric results obtained at Montpellier, together with the frequency curves for sun-spots, faculæ, and prominences, Dr. Loisel shows that they are distinctly analogous, but the terrestrial variation is an inversion of the solar variations.

## THE OKAPI MONOGRAPH.[1]

SHORTLY after the arrival in London of the first complete skin of the okapi, the administration of the Congo Free State at Brussels sent urgent orders to its officials on the Uganda border to procure other skins, and also skeletons, of the then newly discovered animal. In due course these orders were carried out, and a representative series of specimens received at the Museum of the Free State at Tervueren, a few miles out of Brussels, some of which were mounted for public exhibition, while others were reserved for study. With commendable promptitude, the administration thereupon took steps to arrange for a monograph of the okapi, the preparation of which was entrusted in 1902 to Dr. Forsyth Major, who had already made a special study of the giraffe group.

During the same year, that gentleman visited Belgium for the purpose of studying the Tervueren specimens, upon which he published several preliminary notes in *La Belgique Coloniale*. Coloured and other plates for the monograph were also prepared under his direction. Nevertheless, after something like two years' delay, no MS. was forthcoming, and the Secretary of the Free State felt himself compelled to seek another author. Accordingly, Prof. Julien Fraipont was approached, who, after some demur, eventually consented, at the close of 1905, to undertake the work, and to use, so far as practicable, the plates prepared under Dr. Major's direction.

The result of these negotiations is the present elaborate and richly illustrated monograph, which bears on every page testimony to the author's diligence and industry. In one respect the delay has been of very considerable advantage, since it has admitted of the examination and comparison of a much larger series of specimens than was available in 1902–3. Most of these, it should be mentioned, originally belonged to the authorities of the Free State, by whom examples have been presented to the museums of Stockholm, Lisbon, Paris, Madrid, and Antwerp. Altogether, the author had at his disposal no fewer than a dozen skins, seven skeletons, and eleven skulls. With such full material, the monograph could scarcely fail to be otherwise than in a great degree exhaustive.

Following the usual rule, the monograph opens with a historical sketch of the discovery of the okapi and the subsequent acquisition of fuller knowledge of its structure and affinities. In the course of this chapter the author discusses the identification of the okapi with "Set-Typhon" of the ancient Egyptian frescoes and sculptures—an identification which he refuses to admit. The idea is, however, by no means dead, a special work on the subject having been published in Paris last year.

The next chapter is devoted to the general external form and colouring of the creature, in the course of which the author expresses his opinion that, if we except the zebra-like pattern on the limbs and the general brilliance of tone (rather a large order, by the way), the coloration is not unlike that of many antelopes. Of great interest are a number of figures of the limbs of different individuals to display individual variation in the matter of colour-pattern. The skeleton forms the subject of the following chapter, in the course of which the author devotes particular attention to the nature of the horns of the giraffe and okapi, and their correspondence with those of other ruminants. The "vellericorn," or skin-covered, type presented by the former is evidently the most primitive, and there can be equally little doubt that the cap of bare bone at the tip of the okapi's horn represents the deer's antler. A further inference from the latter identification is that the shedding of the antlers in deer is an acquired character, and it is noteworthy that some Tertiary stags seem to have permanent antlers, while in several of the less specialised living species, such as the Indian sambar, the shedding does not take place annually. Front views of a male and a female skull are given, although little is said with regard to individual variation in skull-width, of which we believe there is a good deal. In mentioning the existence of a double bicipital groove to the humerus, the author scarcely gives sufficient emphasis to the fact that this feature is absolutely distinctive of the Giraffidæ.

With regard to the habits of the okapi, Prof. Fraipont has, of course, nothing new to relate, but the photographs he gives of the equatorial forest seem to confirm the suggestion that the striping of the limbs and hind-quarters serves the purpose of breaking up the outline of the creature in the comparatively clear basal zone of the forest. Copious extracts are given from the writings of those who have obtained more or less nearly accurate information with regard to the okapi's haunts and mode of life.

A casual survey of the four coloured plates included among the illustrations will probably lead to the belief

[1] "Contribution à la Faune du Congo." Vol. i., Okapia. By Julien Fraipont. Pp. 118; 38 plates. *Annales du Musée du Congo.* Zoologie, ser. 2. (Brussels, 1907.)

that the author recognises two species of okapi, as two of the plates are lettered *Okapia liebrechtsi*. This is due, however, to the fact that Prof. Fraipont had to use the plates prepared for Dr. Major, and from the descriptions of the plates we learn that the author recognises only a single species—the typical *O. johnstoni*. In this we think he is certainly right, and that some other factor than specific distinction will have to be sought to explain the differences between individual okapis in the matter both of colour-pattern and of skull-characters. If there be two kinds, the okapi certainly forms a strange exception to the law of "geminal species."

Both the author and the administration of the Congo Free State are to be congratulated on this handsome and exhaustive monograph. R. L.

## IRON AND STEEL INSTITUTE.

THE annual meeting of the Iron and Steel Institute was held in London at the Institution of Civil Engineers on May 14 and 15, and was largely attended by members from the various iron-producing districts of this country and abroad. Sir Hugh Bell presided.

The report of the council, read by Mr. Bennett H. Brough, the secretary, showed that the institute had made considerable progress during the year 1907. The membership amounted to 2100, and the financial prosperity was a matter for congratulation. In presenting the accounts, Mr. W. H. Bleckly, hon. treasurer, announced that Mr. Andrew Carnegie, past-president, had presented to the research fund the further sum of eleven thousand dollars, bringing his total benefaction to one hundred thousand dollars. In moving the adoption of these reports, the president announced that the institute had secured larger premises in the same building as those previously occupied, and that the reading-room accommodation had been much improved.

The president then handed the Bessemer gold medal to Mr. B. Talbot, inventor of the continuous open-hearth steel process, who expressed his acknowledgments.

The first paper read described improvements in plate-rolling mills. In it Mr. A. Lamberton described a new form of plate-mill now successfully at work at the Glasgow Iron and Steel Works for rolling light plates. The paper, on the physical qualities of steel in relation to its mechanical treatment, contributed by Mr. James E. York (New York) contained suggestions for changes that might result in the production of more trustworthy rails and other similar sections than those now produced by ordinary methods. The heating of the ingots is a matter of great importance, and it is recommended that the finishing temperature should be as low as possible to get the best results, and that the initial temperature should not exceed 950° C. For solidifying ingots the author's method of transverse rolling may be applied.

Dr. T. E. Stanton, of the National Physical Laboratory, described a new fatigue test for iron and steel, in which a combination of rolling abrasion and alternate bending is used. The machine designed for the purpose was exhibited and described.

Prof. B. Igewsky (Kieff) submitted a paper describing a small electric furnace of novel design erected for experimental purposes at the Kieff Polytechnic Institute. It is a rotating cylindrical furnace, with its axis horizontal, built up of fire-brick blocks with contact pieces rubbing against the outside surface. Most of the heating is done by the passage of the current through the inner surfaces of the refractory material, which, when red hot, becomes a conductor. A continuous current of 250 volts and 50 amperes is employed. Experiments for the production of steel from cast iron by the ore process were successful.

The meeting was then adjourned until May 15, when the first paper was read by Mr. F. J. R. Carulla (Derby), who directed attention to the difficulty in finding cast iron suitable for use in the construction of chemical plant. For some purposes, as, for example, ammonia stills, cast iron seems everlasting, and even acid chemicals have sometimes little action on cast iron. Yet when hydrochloric acid is in question, cast iron succumbs like any weaker vessel.

It was announced that the council had awarded Carnegie research scholarships, each of the value of 100*l*., to T. Baker (South Wales), R. F. Böhler (New York), W. Giesen (Mexico), E. Preuss (Germany), and L. P. M. Révillon (France). The president then handed the Carnegie gold medal for research to Dr. Carl Benedicks, of Upsala University, and stated that the reports submitted by the eight holders of research scholarships were considered to be of sufficient merit to warrant their publication in the journal of the institute.

Mr. E. F. Law exhibited some striking lantern photographs illustrating the application of colour photography to metallography. With the aid of Lumière's autochrome plates it is possible to obtain a photograph in colour on a single plate and by a single exposure. In order to distinguish the constituents, the polished specimen of an alloy is heated until a film of oxide forms on the surface. Owing to the different rates at which the constituents oxidise, they assume different colours, and can be readily distinguished in the coloured photograph.

The utilisation of blast-furnace slag formed the subject of a paper read by Mr. C. de Schwarz (Liége), in which he reviewed recent processes for making slag bricks and cement. Blast-furnace works, especially those producing grey pig iron, have evidently still a large field for improvement by utilising their slag for such purposes.

Mr. Walter Rosenhain gave a detailed description of the metallurgical and chemical laboratories in the National Physical Laboratory, and Mr. Wesley Lambert gave an interesting account of the pyrometric installation in the gun section of the Royal Gun and Carriage Factories, Woolwich.

The eight reports on research work submitted by holders of Carnegie research scholarships showed that a large amount of very valuable work is resulting from the funds placed at the disposal of the institute by Mr. Carnegie. The investigation described by Mr. E. Hess (New York) was carried out at a plant at Monterrey, Mexico, its object being to ascertain the microscopical structures of steels the carbon content of which is above 0·9 per cent. at various temperatures above the critical point. The rusting of iron was dealt with by Mr. J. Newton Friend (Suffolk), whose results point to the fact that the rusting of iron is primarily the result of acid attack. The object of the research described by Mr. D. M. Levy (Birmingham) was to investigate the influence of sulphur, as it affected the relations of carbon and iron, and by a series of coordinated thermal, mechanical, chemical, and microscopic tests to determine how far this action could be traced to any combination or reaction between these three elements, or what explanation could be elicited for it.

No evidence was found to support the view that chemical union between iron, carbon, and sulphur is the cause of sulphur tending to retain carbon in the combined form in irons. The purely physical—or rather mechanical—effects of the sulphide observed in the research appear to offer a satisfactory explanation of its action, exercised even by very small proportions.

Mr. A. Hiorth (Christiania) gave the preliminary results of trials in refining iron and steel by means of vapours of metallic sodium. He finds that iron treated in this way is more fusible and will remain molten longer than other iron, and that such treatment will remove the oxygen. The research submitted by Mr. B. Saklatwalla (Charlottenburg) on the constitution of iron and phosphorus compounds was made with the view of supplementing Stead's chemical researches by a complete thermal and metallographic investigation of the subject. The function of chromium and tungsten in high-speed tool steel was investigated by Mr. C. A. Edwards (Manchester); and Mr. H. C. Boynton (New Jersey) submitted a continuation of his researches on the hardness of the constituents of iron and steel.

Lastly, Dr. Carl Benedicks (Upsala), in a memoir for which the Carnegie gold medal was awarded, gave the results of experimental researches on the cooling power of liquids, on quenching velocities, and on the constituents troostite and austenite. He finds that the essential condition for a quenching liquid to give effective cooling appears to be a high latent heat of vapour, and so low a temperature that the vapour bubbles formed at the surface of the metal may be easily condensed in the surrounding liquid. The rate of flow of the liquid has very little influence on the effectiveness of the cooling. The investigations of cooling velocities were made with an automatic quenching apparatus and temperature calibration device, with a string galvanometer, calibration of which instrument has been investigated. The cooling velocity is considerably lowered with increasing carbon content, and possibly silicon has a similar effect. Results are given confirming the theory that troostite is a solid colloid solution of cementite in iron, or, in other words, a pearlite having ultra-microscopic particles of cementite. The last section of the report is devoted to the study of austenite, for which a new etching medium, 5 per cent. alcoholic solution of metanitrobenzolsulphonic acid, was found to be of use. Austenite was observed to be more liable to rusting than martensite. The most important fact found concerning the preservation of austenite in carbon steel is that it requires a high mechanical pressure. Austenite never occurs in the outer layer of a hardened specimen, but it is entirely erroneous to ascribe this to oxidation; it has been shown to depend on the lack of the necessary pressure.

The annual dinner of the institute was held on May 14, with Sir Hugh Bell in the chair. Four hundred members and visitors were present, the principal speakers being Sir Edward Grey, Secretary of State for Foreign Affairs, Sir W. H. White, K.C.B., the Right Hon. J. L. Wharton, Sir Walter Runciman, Mr. R. A. Hadfield, Viscount Ridley, and General Baden-Powell.

## SCIENTIFIC AID TO EGYPTIAN AGRICULTURE.[1]

FEW of the changes effected during the past decade in our management of the Crown colonies, India, and Egypt will be of more lasting benefit than the establishment in them of scientific, as distinct from the ordinary administrative, departments of agriculture. Although they have only been working a short time, some of them have already rendered very useful service, and give promise of even better things in the future; indeed, in this respect these countries are usually better off than the self-governing colonies—one might almost add than ourselves; in proof it is only necessary to refer to the admirable work accomplished in Jamaica and in the Transvaal, where, on the advent of self-government, it was decided to maintain the scientific department.

The volume before us contains an account of the work done by the scientific staff of the Khedivial Agricultural Society. More than half of it is devoted to cotton, the staple Egyptian crop.

Mr. Willcocks gives some notes on the Egyptian cotton-bug or cotton-stainer (*Oxycarenus hyalinipennis*), an insect which receives its name from the fact that it stains the fibre either with its excrements or with the juices of its body, but which in addition inflicts other damage by sucking the juices from the bolls and the seeds. Once the pest has invaded a cotton field there appears to be no way of getting rid of it, but various suggestions are given for keeping it down. Mr. Willcocks has worked out the life-history, and the stages in its development are shown in a beautiful coloured plate by Miss Connie Beard.

This is followed by a long paper, or rather a collection of papers, by Mr. Lawrence Balls, dealing mainly with heredity in cotton. The cotton plant follows Mendel's laws of gametic segregation in certain of its characters, but the practical problems involved are likely to prove difficult of solution. The history of cotton in Egypt has not yet been worked out; the crop is undoubtedly of great antiquity, and some indigenous culture still exists in the Soudan. But the modern crop is not indigenous; it is closely related to Sea Island cotton, from which, indeed, it has probably sprung, since Sea Island cotton was certainly imported into Egypt in 1822. It is not, however, a pure type. Mr. Balls shows that cross-fertilisation takes place to a certain extent under field conditions, and the accumulated effect of this has been to convert the crop into a mass of hybrids. This is no doubt of prime importance in studying two of the most pressing practical problems, the deterioration of the crop in yield and quality and the multiplication of a weed cotton in the fields. Much can be done by selection to get rid of the weed cotton, but selection alone cannot solve the problem, since there will always remain the splitting forms arising from natural crosses between the wild and cultivated varieties. The only permanent solution is to breed pure types, and though Mr. Balls is aware of the special difficulties involved (notably the fact that many of the characters of importance to the manufacturer and cultivator are dominant), he is quite hopeful of the result.

Cotton is not the only hope of the scientific staff. The Nile Valley is well adapted to wheat cultivation, and was in Roman times a great wheat-producing district. To-day wheat is actually imported, but it is pointed out that the crop might very well come into the rotation with cotton, so that Egypt could once again take a place among the wheat-producing countries of the world.

Mr. Hughes contributes some notes on Egyptian and Soudan soils. Generally speaking, the Nile soils do not contain much organic matter, and the "total" phosphoric acid is not high, but a large proportion is "available," so that Dyer's method may show 0·02 per cent. to 0·08 per cent. In spite of this, however, application of superphosphate has been found beneficial. We may expect some very interesting and important results when the manurial requirements of these soils, as ascertained by field trials, are compared with their chemical composition. It would also be desirable to get out the full mechanical composition of some of the typical soils of known history. Mr. Burns gives an interesting series of analyses of the solids dissolved in the Nile water, samples having been taken for this purpose every month during 1906. The results will be of great value to students of the Nile flood.

Altogether, the work is very satisfactory, and is full of promise for the welfare of Egypt.

E. J. R.

[1] "Year-book of the Khedivial Agricultural Society, Cairo, 1906." Pp. 219. (Cairo: National Printing Department, 1907.)

## THE PIGMENTATION SURVEY OF SCOTLAND.

THE last half-yearly number of the Journal of the Royal Anthropological Institute contains an important memoir, prepared by two enthusiastic Scotch anthropologists, Messrs. Gray and Tocher, on the pigmentation of hair and eyes among the school children of Scotland. In one respect the methods employed fail to secure that precision which is necessary to an investigation of this kind. Attempts were made to furnish the correspondents with standard colour cards produced by the three-colour lithographic process, but English manufacturers have up to the present been unable to provide them. There seems, however, to be a prospect of overcoming this difficulty by the adaptation of Lovibond's tintometer to anthropological work. The new instrument is described by Mr. Gray in the April number of *Man*.

Even with these imperfect methods the results are valuable. In the first place, the percentage (24·9) of Scotch boys with fair hair is unexpectedly low. The obvious inference is that the pure Norse or English element in the population is by no means predominant, and that there is a dark or brunette element at least equal, and probably greater. The highest density of fair hair is to be found in the great river valleys opening on the German Ocean and in the Western Isles. In the former case this probably points to invasions of a blonde race into those regions. Similarly, the higher percentage of fair hair in the Spey valley and in the Western Isles implies inroads of the Vikings or Norsemen. It is perhaps pushing the evidence too far when the writers suggest that the high percentage of fair-haired girls in the neighbourhood of Dunfermline is due to the train of blonde damsels who are supposed to have accompanied the Saxon princess Margaret, who about the time of the Norman Conquest became Queen of Malcolm Canmore.

The survey appears to corroborate the conclusions of Dr. Shrubsall in regard to London slum districts, that the percentage of fair-haired people in industrial towns is very low. For some reason as yet obscure, whether from alien invasion or the influence of environment, in towns like Glasgow and Dundee the conditions are specially unfavourable to the survival of blonde men, while the reverse is the case with women. Another important conclusion seems fairly well established, that improvements in communication do not, as might naturally be expected, tend to homogeneity of type; on the contrary, owing to selection centres or to some obscure influence of environment, all improvements in transport apparently tend to make the race more heterogeneous.

The part of the country in which dark hair specially prevails is the extreme west. "If," write the authors of the memoir, "we assume for reasons given above that the pigmentation of girls represents more nearly the pre-Norse inhabitants, this native type has crowded into the Isle of Skye and the opposite coasts of the mainland. If the Dalriadic Scots, who invaded Argyllshire in the fifth century, were a dark race, and the invaders who settled there were men only, that would account for the darkest region in the boys' map being in Argyllshire. The Hebrides have been so much affected by the Viking and Norse invasions from Scandinavia which have passed round the coast of Scotland that they have a much smaller percentage of dark type than the islands and mainland lying further east. The Isle of Lewis has a higher percentage of dark girls than boys, indicating the presence of a pre-Norse dark native population. The south-west corner of Scotland in both the boys' and girls' map is darker than the average; and since, in historical times, the Picts inhabited this region, this evidence points to the conclusion that the Picts were a dark race."

Such wide-reaching conclusions, in the present state of our knowledge, are obviously premature, and too much stress is laid upon pigmentation as a test of race. But the results of this imperfect investigation are sufficiently instructive to justify the demand for a national anthropometrical survey, which was pressed on the late Prime Minister by an influential deputation, the proceedings being reported in the same number of the journal.

## ACOUSTIC OSCILLOGRAPHS.

AN interesting addition to the phonograph or the gramophone has been designed and made by Mr. Bowron, of 57 Edgware Road. It is well known that the action of a gramophone depends on a spiral line cut in the record disc. When this line is examined with a magnifying glass, it is seen to consist of numerous small oscillatory curves; as the disc rotates the needle that follows these curves actuates a diaphragm, and thus the sounds are reproduced. In other words, the curve cut on the disc is a graph of the various sounds produced by the instrument. Several years ago Prof. Ewing studied the analysis of vowel sounds by examining the corresponding curves cut on a phonograph record. Mr. Bowron has undertaken the task of reproducing on a large scale the curves to be found on a gramophone record: he has accomplished this by means of a small mirror, which is mounted so that it oscillates with the diaphragm of the instrument; a beam of light is reflected from this oscillating mirror and from another mirror which rotates uniformly, with the result that a luminous curve of about three feet amplitude can be thrown on a white screen, and so made visible to a large audience. The variations in this luminous curve can be watched while the corresponding sounds are heard; thus the nature of the oscillations produced in the course of a song or the peformance of an orchestra can be most instructively studied.

It would, no doubt, be possible to obtain gramophone records of the various vowel sounds, and to study the corresponding oscillations in a similar manner. In teaching the elements of harmony, it would be interesting and instructive to project on a screen curves showing the characteristics of the various harmonious and dissonant intervals, while the corresponding sounds are rendered audible; and this also could be done by the aid of Mr. Bowron's invention.

Of course, for the curves to correspond exactly to the sounds, it is imperative that the oscillating mirror shall have a very small period of vibration—a period much smaller than that of any of the oscillations which it is necessary to reproduce. Hence the mirror and the mechanism by which it is actuated must be made as light as possible. Some difficulty has been found in obtaining an oscillating mirror large enough to reflect sufficient light to produce curves visible to a large audience, and at the same time light enough to have a period as small as is required; but the progress already made indicates that complete success may ultimately be obtained.

Mr. Bowron has also adapted a Koenig's manometric flame to indicate the acoustic oscillations produced by a gramophone; were it not for the fact that the variations in the shape of the flame must be interpreted before the precise character of the oscillations can be known, this method would be the preferable one. Mr. Bowron's inventions are certain to be appreciated, not only as an educational aid, but also as affording an interesting spectacular display for public entertainments.

E. E.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ST. ANDREWS.—In order to remove misapprehensions which have apparently arisen upon the subject, announcement is made that the University Court—the patrons of the Chandos chair of physiology in the United College, St. Andrews, now vacant—has resolved that the appointment should be open, and that the person to be elected should be the person deemed to be the best candidate, whatever may have been his previous sphere of work. The Court is not pledged to any one candidate, and the election is not a foregone conclusion.

CAMBRIDGE.—The election of a professor of biology will take place on Monday, June 8. Candidates are requested to communicate with the Vice-Chancellor on or before Saturday, May 30.

Mr. C. Shearer, of Trinity College, has been nominated to use the University table at Naples for five months from May 1, 1908.

The professor of botany gives notice that the botany school will be open for practical work during the long vacation. A practical course in elementary systematic botany (flowering plants) will be given in the elementary laboratory on Tuesdays and Saturdays at 9 a.m., beginning Tuesday, July 7. Fee, *1l.* *1s.* A series of botanical excursions will be arranged.

Prof. Larmor has been appointed a member of the board of electors to the professorship of chemistry until February 20, 1910, in succession to Lord Rayleigh, who has resigned his place on the board.

The general board of studies, acting on a memorandum received from the board of geographical studies, recommends a re-construction in the staff engaged in teaching geography in the University. It is proposed that the readership of geography, which becomes vacant in the Michaelmas term of this year, be suppressed, and to establish in its place three lectureships in geography. One of these lectureships will be on historic and economic geography, and will be in connection with the special board for history and archæology. The second will be in regional and physical geography, and it is proposed to connect this with the special board for biology and geology. The third will be a lectureship of surveying and cartography in connection with the special board for mathematics. The salary of each of the first two mentioned lectureships will be *150l.* per annum, and that of the last *50l.* per annum. The last two named will be known as the Royal Geographical Society lectureships in their respective subjects. The council of the Royal Geographical Society has offered to contribute *200l.* a year for three years to the geographical education fund. This offer the board recommends should be gratefully accepted. The University will pay a like sum to the same fund.

THE second annual conference of the Association of Teachers in Technical Institutions will be held in London at Whitsuntide, on June 6, 8, 9, and 10. The delegates will meet on Saturday, June 6, and in the evening there will be a conversazione at St. Bride's Institute, E.C. On Monday, June 8, the president, Mr. C. Harran, will deliver an address, and there will be papers on :—(*a*) Group courses and continuation schools; (*b*) homework and tutorial classes; (*c*) commercialism, the schools, and the decorative arts; (*d*) modern education—the technical phase. On

June 9 there will be a discussion on trade and technical schools, and on the evening of the same day the annual dinner of the association will be held at Anderton's Hotel, Fleet Street, E.C. All interested in technical education are cordially invited to attend the meetings and discussions.

WE learn from the *Pioneer Mail* that the Government of the Maharaja of Mysore is about to award four scholarships—of which two will be for mining and metallurgy, including electrometallurgy—of the value of 200*l.* each per annum, for the year 1908, for study in some British or other recognised university or approved technical institution. These scholarships will be open to all Indians who have taken with credit a degree in arts, medicine, or engineering in an Indian or other recognised university, provided that when qualifications are otherwise equal preference shall be given to candidates who are natives of Mysore or who have taken a degree from a Mysore college. The selection of candidates will be made in August. From the same source we notice that, of 157 students selected in the past three years by the Association for the Advancement of Scientific and Industrial Education of Indians to proceed to foreign countries, 100 have availed themselves of the opportunity, while the fifteen returned students have all found suitable employment.

THE second volume of the report of the U.S. Commissioner of Education for the year ending June 30, 1906, is now available. It gives a very prominent place to statistical information, designed to show the progress which continues to be made in American secondary education. School education in the States is divided according to a well-devised scheme of studies into twelve grades, and the first eight constitute what, in this country, would be called elementary education, and the grades from nine to twelve inclusive correspond to our secondary schools. The number of American secondary-school pupils in both public and private institutions in 1890 was 367,000, or about 5900 to the million of population; in 1895 the number had increased to 539,700, or 7900 to the million; in 1900 the number was 719,200, or 9500 to the million; while for the year 1906 the number aggregated 924,400, or about 11,000 to the million of population, or more than 1 per cent. The growth of public, as compared with private, secondary schools has been remarkable. The number of public schools, which in 1890 was 2526, had in 1906 grown to 8031, and they educated 87·66 per cent. of the total number of secondary-school pupils. On the other hand, the number of private secondary schools, which increased up to 1895, has since that time steadily decreased. In 1906 the number of private schools was 1520. Of the public secondary schools of the country, there were forty for boys only and twenty-nine for girls only, all the others being co-educational. Of the private schools, 304 were for boys only, 500 for girls only, and 725 co-educational.

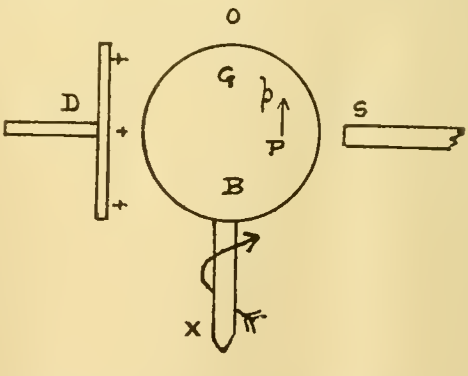
THE annual report of the superintendent of education of the public schools of Nova Scotia for the year ended July 31, 1907, contains, with much other useful information, reports on technical education by the director, Prof. F. H. Sexton, and on the Nova Scotia College of Agriculture by its principal, Mr. Melville Cumming. On April 25, 1907, an Act relating to technical education passed the Nova Scotia Legislature, and led to Prof. Sexton's appointment as director of technical education, with charge of all the schools established under the Act. The schools provided for are:—(i.) a technical college in the capital city of Halifax, to provide professional training in mining, in civil, electrical, metallurgical, and mechanical engineering, and in industrial scientific research generally; (ii.) local technical schools to be established in various industrial centres; (iii.) coal-mining and engineering schools in colliery centres. The college is to be supported by the Government solely, and by private benefactions if such become available. The expenses of the coal-mining and engineering schools are at present defrayed altogether by the provincial treasury, and the local technical schools are supported jointly by the locality and the central government. The first step in organisation was to obtain information regarding the status of existing mining and engineering schools, and the attitude of workmen, employers, and local authorities towards the proposed local technical schools. The engineering schools seem to have been conducted in such a manner that they fulfilled most of the demands on them, and up to the end of the period with which the report deals it was not considered necessary to engage instructors to devote their whole time to teaching. In respect of the local technical schools, the greatest interest was found exhibited everywhere by wage-earners, employers, and the general public. Trades unions were found to be definitely opposed to pure trade schools; the unions fear that such schools will give an imperfect knowledge of the trades, produce a surplus of "hot-house mechanics," as they designate them, who will tend to decrease the demand and wages of skilled labour. It was finally decided that the first schools to be established should be evening technical schools to educate the men already employed in the scientific principles underlying their trades. The report on the College of Agriculture shows that the number of students in 1907 reached 132, and that it is expected the total will reach 200 during the present year.

## SOCIETIES AND ACADEMIES.

### LONDON.

Royal Society, January 30.—"On the Generation of a Luminous Glow in an Exhausted Receiver moving in an Electrostatic Field, and the Action of a Magnetic Field on the Glow so Produced." By F. J. **Jervis-Smith,** F.R.S.

A glass bulb, exhausted as a Röntgen tube, was rotated in an electrostatic field and also in a magnetic field. The conditions of the experiment were varied in six ways. The static charge was either positive or negative. The direction of rotation was reversible. The pole maintaining the magnetic field was either S. or N. The relationship existing between the different conditions will be best understood by reference to the diagram, in which D is a charged disc, B the glow-bulb, S the magnet pole. The axis XO of rotation of the glow-bulb B, the axis of the electromagnet, and the stem of the inductor disc D, are situated in the same plane, when the glow-bulb B




rotates about the axis XO in a clock-hands' sense to an eye looking along XO. The metal inductor D being charged positively, it is filled with a luminous glow of a bluish-green colour, but when the S. pole is placed near the bulb the glow matter is deflected in the direction P*p*, and a bright patch of light is produced at G. The charge on D can be reversed, also the direction of rotation and the magnet pole. If while any two of these conditions are kept the same the third is reversed, the direction of deflection of the glow is reversed. The glow-bulbs were exhausted to the same degree of exhaustion as the Röntgen tube by a leading maker of such tubes. The rays emitted have a definite effect on a sensitive photographic plate, giving shadow pictures. The glow-bulb was rotated about twenty times per second; it was found that the intensity of the glow increased as the rotation increased. The distance between the charged inductor and the glow-bulb was varied from 1 cm. to 13 cm. The glow was apparent at 13 cm. In most of the experiments the inductor was charged to about 1200 volts. The diameter of the glow-bulbs varied from 1·5 cm. to 5·0 cm.

February 20.—"Effects of Self-induction in an Iron Cylinder when traversed by Alternating Currents." By Prof. E. **Wilson.** Communicated by Sir William Preece, F.R.S.

Alternating currents up to about 2000 amperes at frequencies varying from 1/45 to 1/360 were supplied to an iron cylinder 10 inches in diameter, and the change of magnetic induction at different depths was obtained from readings taken with three dead-beat galvanometers connected to coils threaded through holes in the cylinder. The total current in the cylinder was observed on an amperemeter in the circuit. The curves of E.M.F. in the exploring coils were plotted, and by integration the magnetic induction at different depths was obtained. The results show that the effect due to internal self-induction, commonly called "skin effect," is greater the greater the average permeability, and it is shown how it depends upon change of current and frequency. The phase displacement of the E.M.F. curves reckoned from zero of current diminishes with increase of current for a given frequency, and increases with increase of frequency for a given current. From the hysteresis loops of the material the total currents interior to the respective radii were found and plotted against radius as distribution curves, from which the $C^2R$ loss was calculated. The hysteresis watts were also found, and both compared with the watts which would occur if the distribution under continuous current were assumed to persist. For a given frequency, the ratio of the $C^2R$ loss with alternating to those with continuous currents is greater the higher the average permeability. For a given current, the $C^2R$ loss increases with frequency, and the hysteresis loss tends to increase with frequency, but to diminish owing to increased skin effect. The results hold for a cylinder of $n$ times the diameter if the current is varied as $n$, and the frequency inversely as $n^2$. The paper contains tables of figures and curves.

"On the Refractive Indices of Gaseous Nitric Oxide, Sulphur Dioxide, and Sulphur Trioxide." By C. **Cuthbertson** and E. Parr **Metcalfe.** Communicated by Prof. F. T. Trouton, F.R.S.

The refractive index of nitric oxide, purified by fractionation at low temperatures, was found to be 1·0002939 for sodium light. This is about 1 per cent. less than the value found by Mascart.

The index of sulphur dioxide was re-determined in view of the discrepancies between the numbers published by previous observers. The value now obtained, 1·0006609, is in agreement with the results of Ketteler and G. W. Walker, when these are corrected for the density of the gas at 0° C. and 760 mm. The index of sulphur trioxide is, approximately, 1·000737. Both this and the index of sulphur dioxide are considerably below the additive values.

**Faraday Society,** April 28.—Prof A. K. Huntington, vice-president, in the chair.—The planimetric analysis of alloys, and the structure of phosphor-copper: A. K. **Huntington** and C. H. **Deach.** The conditions under which it is possible to estimate the relative proportions of the constituent metals in an alloy by means of the planimetric measurement of the areas of the solid phases exposed in a polished and etched micro-section is discussed. Details of the method are given, and its accuracy is shown by a series of measurements of analysed alloys. The method has been most fully studied in the case of phosphor-copper, of which a number of photomicrographs are shown. In the case of alloys containing less than the eutectic proportion of phosphorus, however, the area of copper crystals is found to be considerably greater than that calculated from the composition determined by analysis. The origin of the discrepancies was traced to the segregation of the eutectic, the copper crystals which separate at first drawing to themselves a portion of the copper of the surrounding eutectic. The crystals are therefore surrounded by a belt of copper phosphide. By measuring the area of this belt, and thence calculating the amount of segregated copper, a correction may be applied to the area of the crystals, and a very satisfactory agreement with the analytical results is thus obtained.—The interaction of aluminium powder and carbon: F. E. **Weston** and H. R. **Ellis.** Very little work has been done on the combination of aluminium and carbon at temperatures lower than that of the electric furnace. The authors now show that aluminium powder and carbon can be made to react at temperatures much below that of the electric furnace. Mixtures of aluminium powder and carbon, wood charcoal, sugar carbon, and graphite have been prepared, in which reaction takes place by starting with a fuse of magnesium powder and barium peroxide, as in Goldschmidt's reaction; other mixtures have been made which only react when heated at temperatures varying from 400° C. to 1000° C. In all cases the products of reaction were found to be aluminium carbide (9·12 per cent. to 65·91 per cent.), aluminium nitride (3·67 per cent. to 42·16 per cent.), alumina (11·07 per cent. to 55·4 per cent.), aluminium, and carbon. The carbide produced is most probably that described by Moissan as aluminium carbide, $C_3Al_4$, since the gas obtained on treating the product of reaction with either water or hydrochloric acid was found to consist of $CH_4$ and H, the latter coming from (1) the action of HCl in unaltered aluminium; (2) action of $NH_3$ on aluminium, the $NH_3$ being formed by the action of water on aluminium nitride.

**Mathematical Society,** May 14.—Prof. W. Burnside, president, in the chair.—The invariants of the general linear homographic transformation in two variables: Major P. A. **MacMahon.**—The order of the group of isomorphisms of an Abelian group: H. **Hilton.**—The calculation of the normal modes and frequencies of vibrating systems (preliminary note): Prof. A. E. H. **Love.**—A question in probability: Prof. J. E. A. **Steggall.**

PARIS.

**Academy of Sciences,** May 11.—M. H. Becquerel in the chair.—The president announced the death of M. Albert de Lapparent.—A planimeter permitting of the integration of the Abelian equation $yy' = Ay^2 + By + C$: Col. **Jacob.** This form of equation occurs in the study of ballistics.—The application of the laws of similitude to the propagation of detonations: MM. **Crussard** and **Jouguet.**—Wireless telegraphy with directed waves: MM. **Bellini** and **Tosi.** The direction of the waves is obtained by the use of aërial conductors formed of closed oscillating circuits disposed in vertical planes without connection with the earth. The transmitter was installed at Dieppe, and two receiving posts were constructed, one at Havre and the other at Harfleur. The signals could be transmitted to either receiving station, and were received only by the station to which they were directed. The signals neither interfere with nor are interfered with by other systems of wireless messages.—The range of the $\alpha$ rays: William **Duane.** It has been shown by various observers that the photographic, phosphorescent, and ionising action of the $\alpha$ rays cease abruptly when the rays have traversed a few centimetres in air, and in the present paper experiments are described which were made with the object of deciding whether the other actions of these rays cease at the same distance. From the form of the curves obtained it is very difficult to decide the exact point at which the range of the $\alpha$ rays ceases, but it was found that the charge of the $\alpha$ particles and their ionisation ceases at the same point.—The electric dispersion of water: F. **Beaulard.** By extending the range of the method previously described to other wave-lengths, there would appear to be some anomalous electric dispersion for the order of magnitude of the electric field studied.—The spectrum of iron observed in the flame of the oxyhydrogen blow-pipe: G. A. **Hemsalech** and C. **de Watteville.** Using the method previously described, the gases feeding the flame were supplied with finely divided particles of the metal torn from electrodes by the electric spark. A table of the wave-lengths and intensities of the observed lines is given, and the results compared with the arc spectrum of iron.—Contribution to the study of the photographic grating: H. **Calmels** and L. P. **Clerc.**—Molecular agitation and the Brownian movement: Jean **Perrin.** An attempt to prove that molecular agitation is the cause of the Brownian motion. It results from the proof given that the number of molecules per gram of liquid is of the order $6{\cdot}7 \times 10^{23}$.—An electro-optic phenomenon in air containing dust in suspension: Eugène **Bloch.**—The commensurability of the atomic weights: M. **Hinrichs.**—

Thorium fluoride and oxyfluoride: Ed. **Chauvenet.** When hydrated thorium fluoride is heated to about 800° in a current of pure dry HF, thorium oxyfluoride, $ThOF_2$, remains. The fluoride, $ThF_4$, can be obtained by the action of anhydrous gaseous hydrofluoric acid on thorium bromide.—The combinations of silver selenide and the selenides of arsenic, antimony, and bismuth: H. **Pélabon.** The existence of compounds of these selenides is deduced from a study of the fusibility curves of their mixtures.—The origin of atmospheric ozone and the causes of the variation of carbonic acid in the air: H. **Henriet** and M. **Bonyssy.** Ozone is produced by the ultra-violet rays of the sun in the upper atmosphere, and the amount near the earth increases when air currents set in from these upper regions. The reduction in carbon dioxide found to accompany an increase in ozone is an indirect effect, due to simple dilution of the lower air with the purer air of the higher atmosphere.—The properties of starch in relation to its colloidal form: E. **Fouard.** A study of starch solutions after filtering through collodion films of different permeabilities.—The properties of the metallic thiosulphocarbamates: Marcel **Delépine.**—Contribution to the study of the amido-derivatives of *o*-dibenzoylbenzene: A. **Guyot** and P. **Pignet.**—A new method of tanning: Louis **Meunier** and Alphonse **Seyewetz.** Skin can be tanned with quinone or quinhydrone. Skins thus tanned present great affinity for both acid and basic colouring matters.—The thermal effects of high-frequency currents on the organism: A. **Zimmern** and S. **Turchini.** Experiments made in dogs and men show that a rise of the body temperature of between 0°·1 and 0°·4 is caused by high-frequency currents. As a method of thermotherapy, the authors regard this method as much preferable to the external methods in current use (hot baths, sun baths, &c.). The application to certain circulatory troubles is indicated.—Researches on the distribution of the antivirulent substance in the humours of vaccinated animals: L. **Camus.**—A new Oospora (*Oospora lingualis*) associated with *Cryptococcus linguae-pilosae* in black tongue: Fernand **Guéguen.**—The formation and disappearance of acetaldehyde under the influence of alcoholic yeasts: A. **Trillat** and M. **Sauton.** Experiments are cited showing the formation of aldehyde under the action of yeast; the reverse action also takes place, since when aldehyde is gradually added to an alcoholic liquid containing fresh yeast in suspension, the aldehyde disappears.—The nutritive value of some peptones for different microbial species: H. **Dunschmann.** Comparisons were made of the nutritive action of Dufresne, Martin, and vegetable peptone on cultures of typhoid, *Bacterium coli*, anthrax, and diphtheria.

## DIARY OF SOCIETIES.

*THURSDAY*, MAY 21.

ROYAL SOCIETY, at 4.30.—On Some Features in the Hereditary Transmission of the Albino Character and the Black Piebald Coat in Rats. II.: G. P. Mudge.—A Further Note on the Nutrition of the Early Embryo, with Special Reference to the Chick: E. Emrys-Roberts.—The Antagonistic Action of Calcium upon the Inhibitory Effect of Magnesium: S. J. Meltzer and J. Auer.

ROYAL INSTITUTION, at 3.—The Chemistry of Photography: Dr. Alexander Scott, F.R.S.

ROYAL SOCIETY OF ARTS, at 4.30.—The United Provinces of Agra and Oudh: Sir J. J. D. La Touche, K.C.S.I.

CHEMICAL SOCIETY, at 8.30.—Hydroaromatic Ketones, Preliminary Note: A. W. Crossley and C. Gilling.—Titani-dihydroxymaleic Acid, and the Detection of Titanium: H. J. H. Fenton.—Some Experiments on Carbon at High Temperatures and Pressures, and Apparatus Therefor: R. Threlfall.—The Sulphides and Oxy-sulphides of Silicon: J. G. Rankin and S. M. Revington.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Recent Progress in Tungsten Metallic Filament Lamps: H. Hirst.

INSTITUTION OF MINING AND METALLURGY, at 8.—The Electrical Equipment of Gold Mines (*continued discussion*): H. J. S. Heather.—The Behaviour of Tellurium in Assaying: S. W. Smith.—The Average Rate of Accumulation and Absorption of Gold Amalgam by Copper Plates: E. Halse.—The Absorption and Accumulation of Gold on Copper Plates: W. F. A. Thomae.—A Journey to Central Asia: A. Adiassewich.

*FRIDAY*, MAY 22.

ROYAL INSTITUTION, at 9.—Recent Researches in the Structure of the Universe: Prof. J. C. Kapteyn.

PHYSICAL SOCIETY, at 5.—On the Spectrum Top: G. P. Sexton.—On the Coefficient of Diffusion: B. W. Clack.—On the Production of Small Alternating Currents of Variable Frequency suitable for Telephonic and other Measurements: B. S. Cohen.

*MONDAY*, MAY 25.

LINNEAN SOCIETY, at 8.—Anniversary meeting.

ROYAL GEOGRAPHICAL SOCIETY, at 3.—Anniversary meeting.

*TUESDAY*, MAY 26.

ROYAL INSTITUTION, at 3.—Animal Heat and Allied Phenomena: Prof. William Stirling.

ZOOLOGICAL SOCIETY, at 8.30.—The Rudd Exploration of South Africa. X. List of Mammals collected by Mr. Grant near Tette, Zambesia: Oldfield Thomas, F.R.S., and R. C. Wroughton.—Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunnington, 1904–5. Report on the Isopoda Terrestria: Rev. T. R. R. Stebbing, F.R.S.—On the Anatomy of Antechinomys and some other Marsupials, with Especial Reference to the Intestinal Tract and Mesenteries of These and other Mammals: F. E. Beddard, F.R.S.—The Armour of the Extinct Reptiles of the Genus Pareiasaurus: Prof. H. G. Seeley, F.R.S.—New Siphonaptera: Hon. N. Charles Rothschild.

FARADAY SOCIETY, at 8.—Presidential Address: Some Aspects of the Work of Lord Kelvin: Sir Oliver Lodge, F.R.S.

*WEDNESDAY*, MAY 27.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.

*THURSDAY*, MAY 28.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On the Theory of Capillarity: Prof. E. T. Whittaker, F.R.S.—Effect of a Cross Wind on Rifled Projectiles: A. Mallock, F.R.S.—Transparent Silver and other Metallic Films: Prof. T. Turner.

ROYAL INSTITUTION, at 3.—The Chemistry of Photography: Dr. Alexander Scott, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

*FRIDAY*, MAY 29.

ROYAL INSTITUTION, at 9.—Ancient and Mediæval Projectile Weapons other than Firearms: Sir Ralph Payne-Gallwey, Bart.

## CONTENTS.

THURSDAY, MAY 28, 1908.

## THE SCIENCE OF THE ELECTRON.

*Modern Electrical Theory.* By Norman R. Campbell. Pp. xii+332; diagrams. (Cambridge: University Press, 1907.) Price 7s. 6d. net.

IF Franklin had re-visited this globe a dozen years ago he would have found his view of the electric fluid in the descendent. The work of Hertz and his successors had completed the work which Faraday and Maxwell began in directing the attention of physicists to the æther as the region in which real electrical actions proceed. The conductor was made to take a secondary place only as a region in which electrical energy ceases to be electrical, being dissipated therein into heat. The supposition of one electrical fluid (or more) was scouted, and relegated to the daily Press.

If, however, his visit had been postponed to the present day it would be far otherwise. Once more recourse is had to a fluid to explain electrical phenomena. The story of modern electrical theory is the story of the re-furbishing of an old idea to form the basis of speculative thought. We have Franklin's idea once more in the ascendant; and the only wonder is that this account of modern electrical theory can be written without a single mention of Franklin's name within its pages. The explanation of the wonder is, of course, that the elaboration peculiar to the modern theory is relatively so important that the mere assumption of a fluid at all, once taken for granted, is not worth mentioning.

The main elaboration consists in assuming that electricity, like matter, is made up of discrete portions; and in speaking of "molecules of electricity," as Maxwell did (though he regarded the expression as "gross" and "provisional"), or otherwise in speaking of "electrons." The idea of "molecules of electricity," based originally on the facts of electrolysis, is needed so greatly to explain the phenomena discovered in the last decade in connection with the discharge through gases and radio-activity that no one questions that it is rightly introduced.

The present book might be called "The Science of the Electron." It is not written for the expert. "It was begun with the idea of providing a text-book from which students, well-grounded in the elementary branches of physics, might obtain some knowledge of the later developments"; and although this scheme has been departed from in some respects, the above quotation from the preface represents fairly well the general scope of the book. There is no doubt that a volume with this aim was greatly needed, and we do not hesitate to assert that Mr. Campbell has produced one of the most interesting, the most connected, and most comprehensive of all the recent books on the subject. On questions so speculative as those with which our author treats there are bound to be differences of opinion; and it will be most useful to direct attention to some of these. We will ask Mr. Campbell, therefore, to be content with the above assurance of our appreciation of his efforts, and will proceed to a few critical remarks.

The subject and the methods are so speculative that we are throughout on the fringe of knowledge, and often we pass over to the other side. There is, perhaps, scarcely a sustained argument in the volume which will not ultimately be subjected to considerable modification. It is this daring nature of the speculation which is one of the charms (though a somewhat dangerous charm) of modern physical writings. The idea of the electron has, indeed, been found so fruitful that everyone is employing it for all it is worth. We doubt if there was ever a time in the history of physical science in which so much unproved hypothesis was employed. The very success which attends its employment is the tempter which leads one beyond justifiable bounds. Take, for example, the idea that because the inertia of an electron is explicable in terms of the electromagnetic field which surrounds it, therefore all inertia is explicable in the same way. This idea takes concrete form in the supposition that all atoms are built up of electrons. The author of this idea no longer worships his creation (the present writer never bowed his knee to it); but Mr. Campbell is still attracted by it. The result is that while, according to Drude, and in recent years J. J. Thomson, the number of electrons in an atom is quite small (comparable, for example, with the atomic weight or the valency), to Mr. Campbell the number in a radio-active material, and probably in others, is at least as great as 400,000.

In making this estimate Mr. Campbell assumes that it is unlikely that the energy of each electron in an atom is greater than $4 \cdot 2 \times 10^{-11}$ ergs, this value being the energy which he calculates as necessary to liberate an electron from the atom. But we must point out that electrons are propelled from radium with nearly the velocity of light, and that therefore, after the work done against the attraction of the positive charge, each possesses energy nearly equal to $\frac{1}{2} \times 6 \cdot 1 \times 10^{-28} \times 9 \times 10^{20}$ ergs, or, roughly, $3 \times 10^{-7}$ ergs. Preserving his other datum unchanged, this gives a minimum number of (say) 60 electrons to an atom of radium. But the other datum is the energy liberated by a radium atom measured by its heating effect; this energy is supposed to be distributed amongst the electrons in the atom. Yet Rutherford has shown that something like 98 per cent. of the heating effect is due to the alpha particles. Until we know something more definite about the alpha particles no calculation on the author's lines can have any weight. Needless to say, we do not claim any greater validity for the estimate we have made above.

Our author regards the explosion theory of photo-electric action as unnecessary, and gives the alternative theory depending upon the accumulation of the effects of forced oscillations.

"The electron continues to take up energy from the light until a velocity is reached, depending only on the nature of the atom and not on the intensity of the light, when its kinetic energy is sufficient to carry it clear of the attraction of the positive atom."

We should have thought that on this explanation the velocity of the electron, when sensibly outside the metal, would have been about zero instead of nearly that of light.

We regret the choice of electrostatic units, while thoroughly approving the adoption of a single kind instead of the mixed electrostatic and electromagnetic units which are so often met with.

Many data employed are those relating to an atom or an electron. There is doubtless gain as well as loss in making use of these instead of the corresponding data for (say) unit volume or unit mass. We think, however, that there is preponderating gain in writing all formulæ so as definitely to indicate to what extent the value accepted for the number of particles in a cubic centimetre influences the numerical result. Thus in the expression for electrical conductivity,

$$\sigma = \frac{1}{4\alpha T} e^2 lu N,$$

$\alpha$ is the gas-constant referred to an electron. Now $\alpha/e$ is known with more certainty than either $\alpha$ or $e$, and there is gain in writing $eN$ as a product, so that the formula would be written—

$$\sigma = \frac{eN}{4T\alpha/e} . lu.$$

Probably the most daring speculation in this book is in connection with the problem of aberration and æther drift. Our author desires to remove the difficulties in connection with this problem by denying the existence of the æther altogether. The scientific man, in accepting the æther, "has fallen into the most glaring errors of the crudest nominalism." Our author's explanation is based upon Faraday tubes. May we suggest that these Faraday tubes seem suspiciously like an æther, but with special properties attributed to it?

In many other respects we think that the author is too dogmatic in his assertions; his exposition would gain if the overbearing tone were modified. The reader also resents the too colloquial character of some sentences, such as, "My own vote is cast, for what it is worth, for the latter." Science does not advance by the mere casting of votes, whatever they may be worth.

Although we do not find ourselves in agreement with everything in this book, it is undeniably a very invigorating study of the subject. The publishers are to be congratulated on securing it, and also on the care taken in producing it. There are exceedingly few typographical errors; as proper names are important, we mention that Spender (p. 216) should be Spencer.

## OCEANIC TIDES.

*Scientific Papers.* By Sir George Howard Darwin, K.C.B., F.R.S. Vol. i., Oceanic Tides and Lunar Disturbance of Gravity. Pp. xv+463. (Cambridge: University Press, 1907.) Price 15*s.* net.

THE syndics of the Cambridge University Press are bringing out in four volumes the collected papers of Sir George Darwin. The first volume is before us, and contains a list of about sixty papers written between 1875 and 1906, that will be distributed over the four volumes.

Sir George Darwin's papers being easily separated into well-defined groups, the collected papers will not be in chronological order, but will be classified according to subject as follows:—Vol. i., Oceanic Tides and Lunar Disturbance of Gravity; vol. ii., Tidal Friction with Astronomical Speculations; vol. iii., Figures of Equilibrium of Rotating Liquid; vol. iv., Periodic Orbits.

The height of the tide at any point at a variable time $t$ must be expressible as the sum of a number of periodic sine or cosine terms, the arguments moving uniformly with the time, and the coefficients being constant. The periods are mostly forced periods, and there is little difficulty in pointing out what they are. In addition there are the free periods. "A dynamical problem of this character," writes Sir George Darwin (p. 350), cannot be regarded as fully solved unless we are able not only to discuss the "forced" oscillations of the system, but also the "free." Hence we regard Mr. Hough's work as the most important contribution to the dynamical theory of the tides since the time of Laplace."

The coefficients of the forced oscillations are indicated by theory to some extent. We have first an equilibrium theory, and then a dynamical theory. ("The problem of the tidal oscillation of the sea is essentially dynamical," p. 349.) By laborious quadratures the effects of continents may be roughly taken into account. Finally we are driven back upon the empirical determination of coefficients from observation. This is dealt with in the sixth paper of the present volume. The work is theoretically easy, but most laborious in practice.

In the ninth paper the author concludes from tides of long period that the rigidity of the earth is about that of steel.

Tide prediction follows naturally, when the coefficients of the various superimposed tides have been obtained. An ingenious machine at the National Physical Laboratory, near Teddington, traces the combined effect of twenty-four different tides upon a chart. In two hours the curve that represents the tides of one year can be traced. It afterwards takes a computer a few days to measure the times of high and low water. The machine is used for forty different ports, and, it may be remarked, is therefore not overworked, as its services are required for eighty hours each year.

On p. 5 there is a schedule of notation of the principal tides, with the speed attached. The speeds are combinations of simple multiples, positive and negative, of the earth's rotation, and the mean motions of the sun, moon, and lunar perigee. The speeds are given numerically on pp. 20, 21, &c. On p. 139 we find tables of coefficients for Port Blair, which quickly and clearly indicate the relative importance of the various tides. On p. 116 we note that an attempt to detect the nineteen-yearly tide failed.

"The actual change of sea-level between 1870 and 1873 [at Karachi] was nearly 0·25 feet, and this is just about nine times the range of the nineteen-yearly tide. It is thus obvious that this tide must be entirely masked by changes of sea-level arising from meteorological causes."

We cannot help thinking that the methods of harmonic analysis described on pp. 157–258 are a little unnecessarily cumbrous. One simplification we should like to suggest. Given the height of the tide at intervals of one solar hour, an approximate period exactly commensurable with a solar hour might always be taken for the tide under analysis. The difference between the true period and the assumed period will then appear as a progressive change of epoch in the successive periods of analysis; meanwhile the assumed period, involving exact repetition after an integral number of hours, immensely facilitates the harmonic analysis, as the present writer has found in an allied subject.

The second part of the volume deals with the lunar disturbance of gravity, and closes with a prediction:—

"I venture to predict that at some future time practical astronomers will no longer be content to eliminate variations of level merely by taking means of results, but will regard corrections derived from a special instrument as necessary to each astronomical observation."

## GARDEN BOOKS.

(1) *Roses: Their History, Development and Cultivation.* By Rev. J. H. Pemberton. Pp. xxiv+336. (London: Longmans, Green and Co., 1908.) Price 10s. 6*d*. net.

(2) *Sir William Temple upon Gardens of Epicurus, with other Seventeenth-Century Garden Essays.* Pp. lxxii+272. (London: Chatto and Windus, 1908.) Price 1*s*. 6*d*. net.

(1) THE English literature of the rose ranks higher, and is more abundant, than that of any other florist's flower. By general consent the most popular book on the subject was the late Dean Hole's work, entitled "A Book about Roses," which is read with interest even now for the personal reminiscences it contains. "The Rose Garden," by the late William Paul, is a standard work with invaluable illustrations, and "The Book of the Rose," by the Rev. Foster Melliar, of which a new edition was published shortly before the author's death, is an eloquent expression of the views and ideas of an enthusiast in respect to the qualities of the exhibition rose, and the methods of cultivation by which the plants may be induced to produce the most perfect flowers.

There are many other published works, some newer, others older, than those mentioned, yet such is the interest in the queen of flowers that rose cultivators will gladly welcome the latest contribution by the Rev. J. H. Pemberton.

Rose-growers visit the exhibitions of the National Rose and other societies, and they are induced to emulate the efforts of the best exhibitors. But if ordinary rose-culture is simple enough to those who are willing to give their time and care to the subject, it is nevertheless true that the production of perfect blooms such as are capable of winning prizes at an important competitive exhibition is attended with all sorts of difficulties. The less experienced growers, therefore, are willing to learn from those who have already achieved success, and certainly no amateur has been more consistently successful over a long period of years than the author of the book under notice.

Mr. Pemberton tells us that his father was an ardent rose-grower, and Mr. Pemberton himself commenced to cultivate roses at the earliest opportunity, being tempted a short time afterwards to enter upon the more adventurous and exciting business of exhibiting his blooms at the competitive exhibitions.

The first portion of the book is devoted to explaining the botanical classification of roses, and to describing some of the more important of the wild species. Some of these are natives of Britain, but the larger number are exotic or foreign.

The author's request in the first chapter that readers will bear in mind that the rose is not an exotic loses much of its point when we remember that the Hybrid Perpetuals, Teas and Hybrid Teas have been obtained entirely from exotic species! These earlier chapters may be recommended to the study of hybridists, for they show clearly that very few species have yet been subjected to cross-breeding, and therefore there are good reasons for the belief that although the present variation in roses is very wide, even greater variation may be expected, and novelties that may establish types altogether distinct from those at present in cultivation.

The author has done well to exhort amateur cultivators to attempt the work of cross-breeding roses for themselves, and notwithstanding that the description given of the processes of fertilisation and fructification is not of scientific exactness, the chapter on raising seedlings will be likely to effect good.

In the second part of the volume Mr. Pemberton talks straight to the cultivator upon the details of cultivation, carefully and thoroughly explaining the systems of vegetative reproduction, such as budding, grafting, layering, and rooting of cuttings; the tilling and manuring of the soil, planting and pruning. In these pages the author's intimate and practical knowledge of his subject is plainly revealed, and the directions are given so lucidly and yet so tersely that to misunderstand them would appear impossible.

As the winner of hundreds of friendly battles Mr. Pemberton is able to afford most valuable hints and directions upon the subject of competitive exhibitions, and whilst his enthusiasm for these will be likely to beget also in his readers a desire to engage in the "Wars of the Roses," his helpful counsel will encourage them to do so with every prospect of obtaining some measure of success.

We are glad that in this book, written as it is by such an enthusiastic exhibitor, the case for the decorative value of roses in the garden is stated so fairly and sympathetically. Not all rose-growers wish to exhibit, but those who do not, equally with those who do, desire to cultivate the best varieties of roses in the best manner, and the decorative gardener will find much in this book that will specially appeal to him.

The illustrations of rose species are reproductions from authentic works on the subject, and in addition to these there are useful designs which illustrate the practical details of budding, pruning, and other operations. We heartily commend this work to the notice of all who aspire to excel in the art of rose-culture.

(2) This volume is a contribution to the "King's Classics" under the general editorship of Prof. I. Gollancz. The first portion, consisting of forty-nine pages, is devoted to an introduction by Mr. Albert Sieveking, who states that the book contains in whole or abstract the Garden Essays of Sir William Temple, Abraham Cowley, Sir Thomas Browne, Andrew Marvell, and John Evelyn, who "in their lives cover the whole of the seventeenth century, and in their writing represent not only some of the best of garden, but of English literature." The introduction is a learned *critique* of the five writers mentioned, and the views contained therein are likely to commend themselves to the reader, for they are well founded, being evidently based on a conscientious study of each. Incidentally Mr. Sieveking gives considerable information upon the history of gardening in Britain, and we commend the reader to study the introduction before reading the selected contributions from the seventeenth-century writers. Of these we regard the prose of Temple as representing a style of literature that is at once pleasing and enlightening. His essay indicates such an appreciation of the art of gardening and intimate knowledge of the best gardens of his day as are certain to appeal to the practical horticulturist.

Notwithstanding our own advanced methods, we are impressed with the insight into cultural problems Temple displays, although some of his opinions were based upon inaccurate premises. His reasons for recommending contemporary gentlemen to possess gardens for themselves are unanswerable, but the lofty air in which they were advanced invests them with a certain amount of humour.

The selection from Cowley includes a letter addressed to Evelyn, and some entertaining verses appreciative of the garden. The extracts from Browne's "Garden of Cyrus" and "Plants Mentioned in Scripture" give the reader some idea of the style of the writer, but they are unsatisfying, and it may be regretted the editor was compelled to curtail them so severely. His observations on grafting prove that numerous experiments were made in this art at that early date. Marvell's verses show an inclination to criticise gardeners for straining after the unnatural and attempting the mixing of plants by purposeful cross-breeding.

Passing to Evelyn's letters to Dr. Browne and others, these are all interesting and informative, whilst the abstracts from his famous "Diary" are not only interesting, but they go to show Evelyn's great knowledge of gardening subjects, and his unusual powers of observation.

## GERMAN SCIENCE MANUALS.

(1) *Bakterien, und ihre Bedeutung im praktischen Leben.* By Dr. H. Miehe. Pp. iv+141. (Leipzig: Quelle and Meyer, 1907.)

(2) *Lebensfragen; die Vorgänge des Stoffwechsels.* By Dr. F. B. Ahrens. Pp. vi+153. (Leipzig: Quelle and Meyer, 1907.)

(1) THIS is an excellent little book. In it Dr. Miehe expounds the story of the microorganisms so clearly that an ordinary, intelligent reader will easily and pleasantly acquire, so far as mere reading can supply it, a trustworthy knowledge of all the fundamental facts and theories of bacteriology. The author takes us from the *De re rustica* of M. Terentius Varro—who seems to have been in the matter of microbes much what Democritus was in respect to atoms—to the "denkwürdigen Brief" of van Leeuwenhoek to the Royal Society in 1683, wherein the famous observer expresses his naïve astonishment at certain frolicsome "animalcula" he had discovered in the human mouth; and our guide does not leave us until we have seen at least the outstanding features of the work of Jenner, Lister, Pasteur, Koch, Eberth, Winogradsky, and the many others whose labours have, each in its degree, helped to illuminate the dim but fascinating pathways which lead into the realms of the infinitely little. He shows us the microorganisms as helpers and as enemies, their modes of increase, and the methods of their destruction; their distribution on land and sea; and the problems of philosophy and of practical life to which the study of these "little fleas" leads.

The book strikes just the happy mean required in a work of this kind. It avoids the trivialities which often embellish expositions of "popular" science. It states the problems clearly, and discusses them soberly, yet withal is no dull and ponderous disquisition; in style it is rather Gallic than Teutonic.

There is a glossary of such terms as are unusual and not sufficiently explained in the text. Given on the part of the reader a very small modicum of scientific knowledge, no mystery of the microorganism dealt with in the book need remain a mystery for lack of simple and lucid exposition.

(2) The "Lebensfragen" contains a number of articles explaining the principles of nutrition and the origin and method of preparation of the chief foodstuffs. To persons who feel more than a passing curiosity about the production of sugar, butter, beer, vine, tea, and so forth, or about the chemical composition of these substances, the descriptions so far as they go may be recommended as trustworthy. But they do not go far enough for the technical reader, and are not intended for him. In each case a sketch of the source, manufacture, and chief chemical characters of the article is given, together with any salient facts of general or historical interest connected therewith. In the chapter on sugar, there is, for example, a description of how the beet-sugar industry was fostered in France by Napoleon. There are also chapters on enzyme action and on the production and application of artificial fertilisers.

The book is written for the general reader who wishes to know, without too much detail, something substantial about the chief things which go to nourish his kind—"the oil to make him a cheerful countenance, and bread to strengthen man's heart." To the English reader, however, there is hardly sufficient novelty, either in the substance of the essays or in their form, to make it worth his while to peruse the book, unless he wishes to give his German an airing.

C. SIMMONDS.

## OUR BOOK SHELF.

*Studies in Blood Pressure: Physiological and Clinical.* Second edition, enlarged. By Dr. George Oliver. Pp. xii+255. (London: H. K. Lewis, 1908.) Price 4s. net.

IN this second edition Dr. Oliver has carried the subject of clinical pulse gauging a distinct step forward. Not only has he greatly improved his compressed-air manometer, but he has made further clinical observations on blood pressure, and he presents the subject in a series of generalisations which cannot fail to be of practical value. The alterations he has effected in his instrument concern each of the three portions constituting it—the glass tube, the armlet, and the apparatus for regulating the air pressure in the tube. This latter is now closed at the distal end, thereby doing away with the necessity for a tap, and effectually avoiding leakage. The armlet no longer consists of a gutta-percha bag which completely encircles the limb, but of a canvas bag, constructed to encircle the limb partially, and provided with three straps; this is a great improvement on the older contrivance, admitting, as it does, of ready adjustment to the limb. Finally, instead of regulating the air pressure by a ball-pump, which causes the index to move along the tube in a series of bounds, Dr. Oliver now employs a compressor fashioned concertina-wise, the size of the chamber being controlled by means of a screw passing between the two boards constituting respectively the top and the bottom, an arrangement which enables the air pressure to be regulated with great evenness and nicety.

Dr. Russell recently directed attention to the fact that a thickened, sclerosed artery may vitiate the findings obtained with the armlet method. In this Dr. Oliver agrees. He finds that the readings he obtains with the armlet method may be higher than those yielded by his earlier spring instrument (hæmodynamometer). In the slighter degrees of arterial sclerosis the difference in the readings obtained by the two methods is small—from 10 to 20 mm. Hg.—but in advanced sclerosis this difference may be much greater, reaching to 40, 50, 70, and even 100 mm. Hg. But, as the author points out, this very difference may be of advantage, affording, as it does, a means of estimating the degree of arterial sclerosis present. He has, moreover, shown that in old people very high armlet readings may be observed in conjunction with low hæmodynamometric readings, without any evidence of cardiac strain—the actual blood-pressure, *i.e.*, being low, though a high degree of sclerosis is present. Only when the arterial wall is normal are the readings furnished by the two methods identical.

One of the most interesting parts of the book is that which deals with the causes of excessive arterial blood pressure. The condition is attributed essentially to constriction of the arterioles as the result of chemical irritation, and the sources of the chemical agents capable of bringing this about are discussed. Dr. Oliver is to be congratulated on the production of these valuable studies.

*Dairy Laboratory Guide.* By Prof. C. W. Melick. Pp. v+129; illustrated. (London: Archibald Constable and Co., Ltd., 1907.) Price 5s. net.

IN some parts of Great Britain, and in most parts of Ireland, dairying is being gradually transferred from the farm to the factory, and an increasing demand for properly trained managers has to be met. Not only must such managers be experienced in the practical operations of butter- and cheese-making, but they must also be able to manipulate the machinery providing power to the dairy, be able to carry out the chemical analysis of milk and cream, possess a knowledge of dairy bacteriology, and be business men. At three of the dairy schools in Great Britain the equipment should be sufficient for providing the course of training required, but no courses specially intended for dairy managers seem yet to be given.

In the State agricultural colleges in the dairying parts of North America, short courses of training for dairy managers are regularly given, and it is for such courses that Prof. Melick has prepared this series of exercises. The book should be useful on this side of the Atlantic by indicating the general lines on which courses can be arranged. In detail, however, the exercises are not entirely suitable for use in this country. The use of the hand churn and butter worker is nowhere referred to, but, though skill in making butter by hand is unnecessary to the creamery manager, the process provides a training which cannot be obtained by more mechanical methods. The three exercises given in hard and soft cheese-making are totally insufficient, and if the plea is offered that there is no time for more, it would surely be better to omit the making of "dried milk cocktail," "buttermilk pop," and a dozen other dietetic delicacies and nostrums which are given as exercises to the students. Again, the economics of dairying should be dealt with far more thoroughly, and the bacteriological exercises should be extended beyond the bacteriology of impurities in milk to the bacteriology of the ripening of cheese and cream.

Nor on literary grounds can the book be recommended in this country as a students' text-book. Partly owing to numerous "printer's" errors, partly to clumsy phraseology, and partly to the use of American technicalities, the meanings of which are unknown to us, portions of the book become almost unintelligible. For example, the student is directed to "make nutrose by boiling together in any alkaline solution dried casein and caustic acid," and again to "make eulactol by dissolving proteic vegetable substance and adding hydrates of carbon, salts, such as phosphate of calcium, cooking salt, or carbonate of sodium, and allow to vaporize" (pp. 107–8). On the other hand, Gray's method for the determination of moisture in butter is admirably described.

*Discoveries in Hebrew, Gaelic, Gothic, Anglo-Saxon, Latin, Basque, and other Caucasic Languages, showing Fundamental Kinship of the Aryan Tongues and of Basque with the Semitic Tongues.* By Dr. A. E. Drake. (Denver: The Herrick Book and Stationery Company; London: Kegan Paul, Trench, Trübner and Co., Ltd., 1907.) Price 25s. net.

JUST as in the sphere of the natural sciences men from time to time arise who believe that they have discovered perpetual motion, or that the circle can be squared, or that one can demonstrate that the earth is flat, so, too, in comparative philology writers are still occasionally found who, in defiance of all the rigidly scientific investigations of Brugmann, Osthoff, Henry, Sweet, Murray, and other philologists, persist, by disregarding phonetic and other ascertained linguistic principles, in connecting together utterly dissimilar tongues, such as the Indo-European languages, Hebrew, and Basque. The author of the above-named work is a writer of this type. His work bristles with philological impossibilities, and he appears to have no conception of the necessity of ascertaining, before comparison of one language with another, the laws which govern the sound changes of the languages compared and of the immediate groups to which they belong. The Hebrew word Satan he thinks is cognate with the Basque Tusuria "by transposition," and the work abounds in similar equations. The volume is unworthy of serious attention, and its only interest arises from its being one of those strange works that spring from the union of a certain kind of learned industry with misdirected ingenuity.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### Fellowship of the Royal Society.

It is well known that under existing regulations the number of new fellows elected to the Royal Society every year is only fifteen. In this way the total number of fellows is kept at about 450. In the early days when this arrangement was made the limited annual number was doubtless sufficient to ensure the election of all the scientific men who really merited the honour, but since those days the scientific world has been growing larger and larger, and at the same time the general standard of work in all branches has become higher.

So long as the annual number of candidates was not more than forty or forty-five the selection of fifteen was not very difficult, and no man who had really done good work had to wait more than two or three years before election. Now, however, the annual number of candidates has increased to eighty or ninety, and this year it is said there were nearly 100 candidates.

Is it not high time, then, that the Royal Society took definite steps to make some change which would meet the requirements of the changed circumstances? Many of the older members of the society are well aware that the present state of affairs is unsatisfactory, and some have expressed their sentiments, but nothing has yet been done.

A simple plan would, of course, be to elect thirty new fellows every year instead of fifteen, but one can see objections to this plan. Has it ever been suggested that the Society should create an associateship and elect associates as well as fellows? The number of fellows might remain as it is, but if a limited body of associates was created, say fifty to begin with, and was increased by the election of twelve or fifteen every year, the pressure would be relieved, and I should think A.R.S. would be preferable to a long-deferred F.R.S. Subsequent elections of fellows could then be made from the associates, and this double election would give better assurance than now exists that none but the best men of the year were admitted to the fellowship.

Enquirer.

### Earthquakes and Earthshakes.

Some of the memoirs, professedly seismological, which have appeared during the last year or two indicate that confusion has arisen from the use of the word earthquake in two distinct and independent senses. As this confusion seems likely to increase unless a modification of our nomenclature is adopted, the introduction of a new term appears to be requisite, however much this may be deprecated on other grounds.

In the generality of cases, the phenomenon represented by the word earthquake consists of a vibratory motion of the ground, of the nature of a wave motion, propagated outwards from a more or less extensive origin or focus. In some cases this disturbance may lead to damage or destruction of buildings, or even to displacement of the surface layers of the earth; but these are secondary results of the molecular displacements involved in the propagation of the wave motion, and, apart from them, the earth, after the earthquake has passed, resumes the same position and condition as before.

Occasionally, however, the word is applied to a disturbance of a wholly different kind, resulting in the formation of fractures and displacements of the solid rock, displacements which are molar and permanent, in the sense that the masses affected by them do not return to their original position after the earthquake has passed.

As the first was the sense in which the word is invariably used in Robert Mallet's classical researches, as it is that which has been sanctioned by long-continued usage, and as the proportion of records and observations, which do not apply to this phenomenon, is probably less than one in a thousand, I suggest that the word *earthquake* should continue to be used in this sense, and that for the other sense, in which it is sometimes used, the word *earthshake* should be substituted. Using the words in this way, we may say that earthquakes, or at any rate severe earthquakes, are frequently, if not invariably, caused by rupture of the earth's crust and the formation of fractures or faults in the solid rock, but these fractures, which are the primary cause of the earthquake, are only the secondary result of the earthshake, the action of which arises at a greater depth, and the ultimate cause of which lies beyond our present ken. The distinction is an important one, and the importance may be greater than will be acknowledged immediately, for some recent studies made by me have indicated a possibility that the earthshake has sometimes a greater extent than the earthquake; in other words, that the area over which permanent displacements of the earth's surface have taken place may be greater than the seismic area, or the area over which the shock was felt.

Incidentally, it may be mentioned that the whole of Prof. See's recent publications on the cause of earthquakes, and the greater part of those by Prof. Hobbs, deal with earthshakes and not with earthquakes as here defined. This is natural, for only the permanent changes, resulting from the earthshake, are of importance to the cosmogonist or the geologist; the transient displacements produced by the earthquake concern them, directly, but little, if at all.

R. D. Oldham.

### Classification and Mathematics.

If mathematics is to be regarded as the science of classification, a view apparently taken in many recent works, it may be worth while to consider whether mathematical teaching should not begin with the use of models of classifications in general rather than with the special classifications in connection with which terms like straight line, rotation, product, power, &c., were originally introduced.

By a model of a classification is meant, for example, a set of things which can be classified by one respect as colour, and cross-classified by another as shape. Similarly, models can be made having three or four or more differentiations, in which any two differentiations have the relation of classification and cross-classification. If each differentiation is supposed to be ordered, we have then spaces of two, three, or four dimensions, of which the classified things form the points. By motion of a point in the space is meant its change in those properties which have been used in the classification. Consideration of the meaning of extension, rotation, and right angle shows the possibility of using the motion of extended bodies to construct a classification of the points of a space, even when we are unable to recognise the differentiations themselves of the space. This is the case met with in ordinary geometry.

As the foundation of geometry lies in the idea of ordered classification, so that of algebra lies in the conception of correspondence between things. A function or one-to-one correspondence is a classification and cross-classification of the things which correspond. For example, a division of a number of models having different markings into two classes by colour and a cross-classification by shape gives a correspondence of the markings in one colour class to the markings in the other. If each marking in one class corresponds to the same marking in the other, we have the correspondence one. Similarly, various circular functions may be illustrated by models, beginning with transpositions. If things which correspond are called operands, and a correspondence of operands a function, then names seem to be needed to mean a correspondence of functions, and for the still higher correspondences which occur. In the usual school course we practically begin with the correspondences of functions, namely, of the numbers one, two, three, &c. It would seem more natural to begin with the correspondence, first, of operands to operands, and then of operands to functions, and define words as power, product, sum in reference to correspondences of operands illustrated by models. For example, a set of things the correspondence of which to another set is under discussion may be called a quantity. Two quantities which correspond to the same quantity correspond to each other; and their correspondence to each other is the product of the correspondence of one to the intermediate quantity and of the intermediate quantity to the other. In the case of vectors, since a vector is a correspondence of points, this would require the term product to be given to what is generally called the sum.

The properties of permutation, association, distribution should be considered in reference to tables of operands before considering tables of functions such as multiplication and addition tables. Space will not allow of discussing the illustration of addition, rule of signs, two-to-two correspondence, &c. The study of irrational numbers and continuous spaces should be postponed to a later stage.

Oundle. C. ELLIOTT.

### An Emanation from Sodium.

DURING the course of some experiments upon the contact potential difference between the alkali metals and glass I noticed that a freshly cut piece of sodium rapidly discharged an electroscope.

Further examination showed that this action occurred only if the gold leaf was charged negatively. Little or no effect was produced if it was positively electrified. The action could be completely stopped by a membrane of celluloid sufficiently thin to give interference colours, and this fact alone points strongly to the discharging action being due to a vapour.

It was found, in fact, that a slight current of air directed so as to carry the supposed gas away from the charged plate of the electroscope enabled the leaf to retain its charge.

The effect is, however, unlike that met with in the case of phosphorus, since the vapour from that substance discharges both positive and negative electricity equally well. It does not, therefore, appear due to the air becoming ionised by a change occurring at the surface of the sodium, but more probably to the emission of an electrified gas. Experiment has shown that the rapid oxidation of the surface has little or nothing to do with the existence of the emanation, and it is very significant that all action ceases after prolonged heating (to melting point) of the metal. After some hours, however, the sodium shows signs of recovering its power to discharge a negatively electrified body.

Since all portions of the same block of sodium do not exhibit the action to the same extent, I am attempting to concentrate those parts which show it most strongly in order to determine whether some new radio-active body is present in the metal or whether there is a radio-active change occurring in the sodium itself.

A slight indication that the emanation is capable of depositing a radio-active layer of matter has been also noticed. The other alkali metals are now being examined and the whole matter fully investigated.

CHARLES E. S. PHILLIPS.

Castle House, Shooters Hill, Kent.

## WIND PRESSURE.

THE importance of a correct knowledge of the pressure exerted by the wind, as affecting the stability of modern structures, was brought prominently before the public by the disaster to the Tay Bridge on the night of December 28, 1879. At that time observatories at which wind pressure was directly measured were rare, the usual observed characteristic of the wind being its velocity as given by the Robinson cup anemometer.

At some stations both the Robinson cup anemometer and the Osler recording pressure plate were installed, and it was for this reason that in the report of the Royal Commission which was appointed in 1881 to consider the question, an attempt was made to state the relation between the probable maximum pressure which would be recorded in a gale and the maximum hourly run of the Robinson cups during that period. Also from records of pressure plates which were considered by the Commission to be not due to instrumental error depending upon momentum, but which represented real phenomena, it was decided that, for structures in exposed situations in this country, a maximum wind pressure of 56 lb. per square foot of surface should be allowed for in the design.

It was, however, felt by engineers at the time that this value, assumed uniform over the whole surface of a large structure, was very excessive, for, as the late Sir Benjamin Baker remarked at a discussion on wind pressure at the Institution of Civil Engineers soon after the report of the Commission was published, if such pressure actually obtained there ought not to be a bridge standing in the country. It was on this occasion that Sir Benjamin Baker stated his conclusions as to the nature of the motion of the wind and the pressures resulting from it, which theory was based, not on elaborate experiments, but on close observation of the behaviour of natural objects in the wind. In his words,

"If leaves and other light objects floating in an apparently steady current were watched it would be found that certain leaves would shoot forward at an increased velocity of 25 per cent. and upwards as compared with the mean velocity. Over a width of 20 feet at the centre of a wide and steady current the mean velocity might thus be constant, whilst over some particular width of 1 foot it might be momentarily fully 25 per cent. higher, and in the case of wind pressure 25 per cent. increase of velocity meant more than 50 per cent. increase of pressure. It was quite possible, therefore, that the large pressure boards might register a notably less pressure than the small boards, and might afford a clue to the reason why railway carriages were not upset when traversing lofty and exposed viaducts."

This appears to have been the first recognition of what may be called the variable structure of the wind as a factor of safety in the stability of structures, and it may be mentioned that the variation predicted by Sir Benjamin Baker was found to exist at points distant 11 feet apart in the experiments of Mr. Dines in 1894.

To test the truth of his conclusions Sir Benjamin Baker erected some wind-pressure plates on the site of the Forth Bridge, each provided with an arrangement for measuring the maximum pressures experienced. One of these gauges was 300 square feet in area, and the others $1\frac{1}{2}$ square feet. Taking the mean of the maximum daily readings for two years, the small-gauge indications were found to be 50 per cent. greater than the large-gauge indications, which was the result anticipated.

In experiments of this kind it is interesting to notice that there is one particular case in which with the assumed structure of the wind the small plate might register a pressure lower than the large one. This is the somewhat rare event when in a gale there is one gust of considerably greater intensity than those which precede or follow it. If during this gust the small plate occupied a region of low velocity, its registered maximum pressure would be lower than that of the large plate. This appears to have happened in one of the gales at the Forth Bridge during the experiments, but its rarity supports the evidence of anemometers, which show that the average gale consists of a series of gusts of nearly equal intensity, so that the probability of the maximum velocity occurring in the region of the small plate is very great. It is important to realise that the above conclusions are in no respect applicable to the pressures which may obtain at any given instant on two plates during a gale, as a little consideration will show that the probability of the small plate occupying the region of lowest velocity at any instant is the same as that of its occupying the region of highest velocity, from which the conclusion follows that the small plate will also register the lowest pressure during the gale.

In the foregoing statements the difference in resistance of large and small surfaces in the wind has been treated as depending entirely on the structure of the wind, that is, it has been assumed that if the wind were a perfectly uniform current in which the velocity over any considerable area was the same, the pressures on the two surfaces would be identical.

This, of course, is not necessarily the case, as there may exist a purely dimensional effect in the resistance of appreciable magnitude, and in the opinion of some authorities the explanation of the Forth Bridge experiments was to be found in this, and not in the structure of the wind.

For this reason, when the wind-pressure experiments were commenced at the National Physical Laboratory in 1904, the determination of the existence or non-existence of this dimensional effect was made the chief feature of the research. These experiments were made on plates and models ranging up to 100 square feet in area, erected on the top of an observation tower 50 feet above the ground, which had a fairly clear space in front of it. After some preliminary work, the method which was finally adopted consisted in the determination of the constant $k$ in what may be called the "equivalent" pressure velocity relation

$$p = kV^2,$$

that is the relation which would exist if the velocity of the wind were uniform.

The determination of this relation when a plate is moved at a known velocity in still air is fairly easy. It becomes more difficult when a plate is suspended in a uniform current of air on account of the trouble involved in forming a correct estimate of the velocity of the current, since, owing to the conditions of flow being disturbed in the region of the plate, it is necessary to place the velocity gauges at some distance from the plate. In the case of a plate exposed to the wind, there is the added complication of the varying structure of the current, and the problem at the National Physical Laboratory was to obtain the "equivalent" pressure velocity relation from observations of the resultant pressure on a plate and the corresponding pressure in a "Dines" tube, which was used as the velocity gauge, distant 10 feet from the edge of the plate. A solution was found in the observed fact that although the pressures at any instant in two tubes facing the wind, and distant 10 feet apart, might differ by as much as 50 per cent., yet if one hundred of these sets of readings were taken at successive intervals of time, the *mean* pressures for each tube were practically identical. From this it was assumed that if a large number of observations of the resultant pressure on the plate and the (simultaneously observed) pressure in the "Dines" tube were made, the means of these experiments would give the equivalent pressure-velocity relation sought. For this purpose 200 observations of this kind were made on each plate tested, two observers operating two sensitive water gauges at the foot of the tower. One of these water gauges was connected by two lead pipes attached to the legs of the tower to the "Dines" tubes, and the other by two similar pipes to an air cylinder in which the pressure varied with the fluctuations of resultant pressure on the plate. The arrangement of the 100-square-feet plate and the "Dines" tube is shown in the photograph (Fig. 1).

The results of experiments on three plates of areas of 25, 50 and 100 square feet gave identical values of the constant $k$ in the "equivalent" pressure-velocity

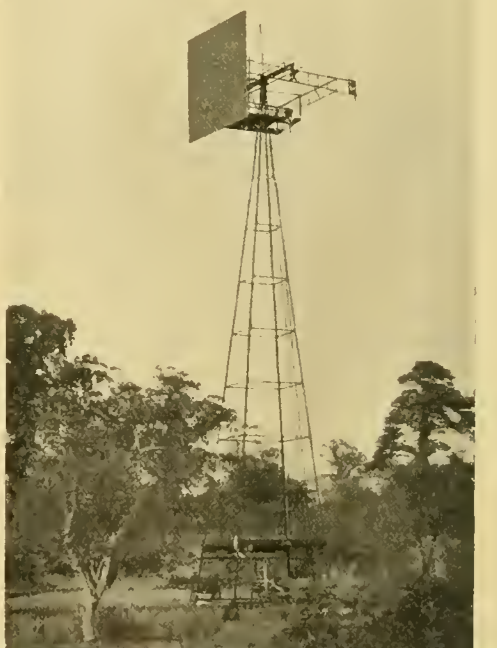


FIG. 1.—Wind Observation Tower with 100-square-feet plate in position.

relation, which in units of pounds per square foot and miles per hour was found to be 0·0032, indicating that for this range in dimensions the purely dimensional effect in the resistance was negligible. There were strong reasons, however, to suppose that it was not negligible for all ranges in dimensions, since the value of $k$ determined at the National Physical Laboratory in 1903 for plates of 2 and 3 square inches in area in a uniform current was 0·0027, and that determined by Mr. Dines in 1890 for a plate of 1 square foot in a whirling machine was 0·0029. This view has been fully confirmed by the publication during the present year of the results of M. Eiffel's experiments on plates let fall from the second stage of the Eiffel Tower. Using square plates varying in area from 10 square feet to five-eighths of a square foot, M. Eiffel found a continuous change in the value of the constant, ranging from 0·0032 for his largest plate to 0·00285 for his smallest plate. The plotted results of M. Eiffel's observations on square plates and those

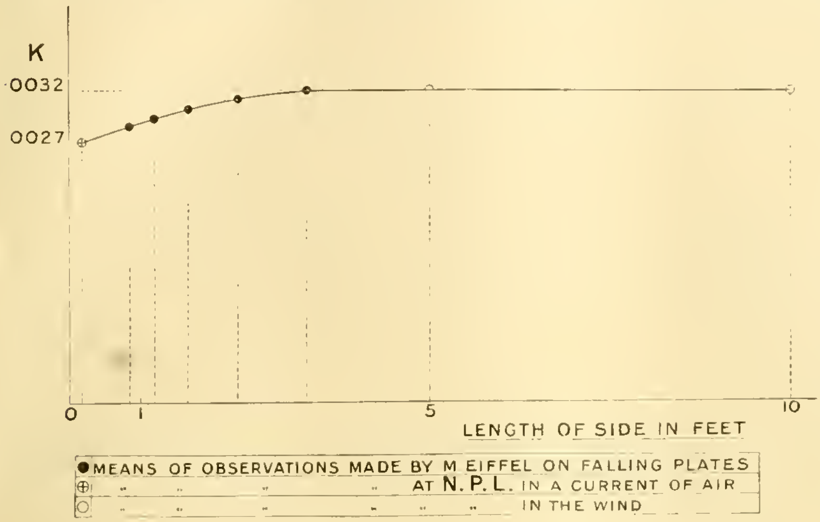



FIG. 2.—Curve showing the dimensional variation in the air-resistance of square plates.

made at the National Physical Laboratory are shown in Fig. 2. There appears, therefore, to be a purely dimensional factor in the resistance of plates, which for the case of square plates has the effect of increasing this resistance up to an area of approximately 10 square feet, when it becomes practically constant.

In the small-scale experiments made in a uniform current of air at the National Physical Laboratory, it was found that although the resistance per unit area of combinations of plates, such as lattice-work, differed considerably from that of square or circular plates, the resistances of similar combinations of plates were approximately the same. To test the possibility of predicting the resistance of a complex structure in the wind from observations on a small-scale model in a current, a model lattice girder was constructed of wood, with a span of 30 feet, and a depth of 3 feet 6 inches. This was placed on the tower (Fig. 3), and a set of observations made on it. A small-scale model of this was made in brass, the linear dimensions being reduced in the ratio of 1 to 42. The resistance of this was determined in the current. On comparing these resistances they were found to have precisely the same ratio as that of the resistances of the large square plates in the wind and the small square plates in the current, that is, the resistance of the large girder was 18 per cent. greater than that of the small one. The conclusion was that the resistance of any structure, however complicated, can be predicted with considerable accuracy from observations on a small model of it, as in the similar problem of the resistance of ships.

The important case of the resultant wind pressure on roofs is more difficult to treat experimentally, owing to the oblique impingement of the wind, which renders the position of the centre of pressure uncertain.

Until recent years it has been customary to treat the forces on a roof due to wind pressure as pressures affecting the windward side only, but from experiments on small models in a current of air, Mr. Irminger, of Copenhagen, has shown that there is a considerable suction effect on the leeward side of the roof, due to the eddies from the ridge. It does not necessarily follow from this that the resultant effect on the leeward side of a roof must be a suction, as this will depend on the pressure inside the building also.

In the National Physical Laboratory experiments a roof model was erected on the tower, having sides each of 56 square feet in area. The results of the observations of resultant pressure on the leeward side showed widely different values, according as the conditions were those of a roof supported on columns through which the wind could pass freely or on walls. In the former case it was found that the reduction of pressure inside the roof due to the eddy from the eaves of the windward side was approximately of the same magnitude as the reduction of pressure outside due to the eddy from the ridge, so that the resultant pressure on the leeward side was practically zero. When the conditions were those of a roof supported on walls, the maximum wind forces were found to exist (*a*) when the doors and windows on the windward side of the building were open and those on the leeward side closed, and (*b*) *vice versâ*. In case (*a*) the maximum wind force was on the leeward side of the roof outwards, and in case (*b*) it was on the windward side inwards. It follows, therefore, that in such a building the roof should be designed so as to be equally strong in each direction.

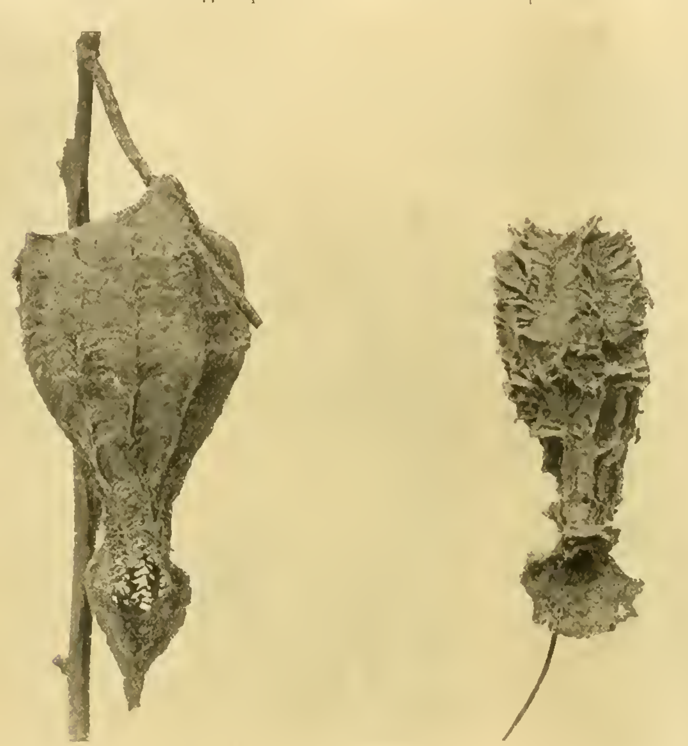
FIG. 3.—Wind Observation Tower with model girder 30 feet by 3·5 feet in position.

It will be seen from this brief sketch that although the difficult engineering problem of the distribution of the pressure of the wind on large structures is not solved, yet when the investigation on the lateral extent of gusts which is now in progress is completed, the only further information which the designer will need is that of the maximum wind velocity which is likely to obtain on the site of the proposed structure.

T. E. STANTON.

## BRITISH MUSEUM GUIDE TO INSECTS.[1]

THE publication of this work furnishes a delightful companion to the charming and highly instructive series of insects exhibited in the gallery of the Museum of Natural History. To the naturalist as well as to the layman this exhibition of the bionomics of the Insecta is a living expression of the incessant activity of those who are responsible for its display, and although Mr. Charles O. Waterhouse informs us that "considerable time must necessarily elapse before the exhibited series of insects can be completed," and that the guide must be looked upon as a provisional one, yet in its present form it gives groups of properly organised facts which cannot fail to instruct and diffuse knowledge by making the study of these animals clearly interesting and accessible to the public.



Nests of species of Ischnogaster, nat. size. Photographed from specimens in the British Museum (Natural History).

A legible plan of the gallery is given, and bold reference numbers in the text will enable the visitor to find with facility any group of insects in which he may be specially interested. Where necessary models are given to illustrate the metamorphoses of various insects, and where possible species likely to be of interest from agricultural or horticultural points of view have been chosen.

The guide is embellished with a number of full-page illustrations, in addition to the numerous figures in the text. With one or two exceptions these have been specially prepared from specimens in the museum, and they help us to an understanding of the text which renders them practically indispensable. In the classification of the Insecta, nine orders are represented in the following sequence:—Aptera, Orthoptera, Neuroptera, Trichoptera, Lepidoptera, Hymenoptera, Diptera, Coleoptera, and Rhynchota. A diagram is given showing the relationship which is believed to exist between these groups, and representatives of a great number of suborders and families are described. Attention is directed to the fact that the guide refers only to the small representative series of insects exhibited in the public gallery; the main collection, which is reserved for the purpose of study in the basement of the institution, contains 1,150,000 specimens, and comprises about 155,000 named species, occupying 13,000 drawers and 602 store boxes. This enormous collection is always available for study, and students at all times receive every attention and assistance at the hands of those who are in charge of the various departments.

In revising this guide we would suggest that reference letters be given to Figs. 14 and 19; that the word *tibia* be added to the diagram in Fig. 18; and that the magnification of Figs. 40, 57, 58, 61, and 62 be indicated.

[1] "A Guide to the Exhibited Series of Insects in the Zoological Department (Insect Section), British Museum (Natural History). London." Pp. 59; with 62 illustrations. (Printed by Order of the Trustees, 1908.) Price 1s.

## PROF. K. A. MÖBIUS.

PROF. KARL AUGUST MÖBIUS, for many years director of the Zoological Museum in Berlin, died on April 26 at the age of eighty-three. He was a notable naturalist, with a broad and cheerful outlook, greatly interested in the habits of creatures, and enthusiastic over their beauty. There are few zoologists who do not know "The Fauna of the Bay of Kiel" by Möbius and Meyer, the two volumes of which form a rich storehouse of observations on the bionomics of a shallow sea. Möbius was probably the first to establish a salt-water aquarium in Germany, and he helped to start the famous zoological garden at Hamburg. He had, indeed, a strong practical sense, and made many useful suggestions in connection with fisheries, oyster-culture, and the harvest of the sea in general.

Möbius was born in 1825 at Eilenburg, in the Prussian province of Saxony; he was trained as a school teacher, but his enthusiasm and ambition were roused by reading the works of Alexander von Humboldt, and he went to Berlin, with a light purse, to study natural history. By giving lessons to others he was able to afford a university training, and he sat at the feet of men like Ehrenberg and Johannes Müller. He became assistant to Lichtenstein, who helped him in 1853 to a congenial teaching post in

Hamburg, where he had time for faunistic studies. In 1868 he went to Kiel as professor of zoology, and it was there that he did what was probably his best work, which is embodied in great part in the book already referred to. He had his share of travel too, and made collections and observations of importance in Mauritius, the Seychelles, and elsewhere. In 1880 he had the pleasure of seeing the completion of the Zoological Museum and Institute at Kiel, to the organisation of which he had devoted himself wholeheartedly. In 1887 he was called to Berlin as director of the new Zoological Museum, a position which he held until the end of 1905. His first zoological paper was on "The Nests of Social Wasps." Of the many others, we may mention "Die Fauna der Kieler Bucht" (along with H. A. Meyer), "Beiträge zur Meeresfauna der Insel Mauritius und der Seychellen," "Die Fische der Ostsee," "Die Bildung, Geltung und Bezeichnung der Artbegriffe." He was particularly interested in marine creatures, in molluscs especially, but he ranged over a wide field, from alcyonarians to fishes. It is but a few months since his "Aesthetik der Tierwelt" was published, expressing with unabated enthusiasm his delight in the sea's endless progeny.

The Festschrift to Möbius with which his students honoured him on his eightieth birthday was an eloquent testimony to his efficiency as a teacher; the list of his papers—faunistic, bionomical, practical, and theoretical—suggests a strenuous life; and his position as president of the fifth International Congress of Zoologists in Berlin in 1901 was an indication of the esteem in which he was so widely held.

## *THE BRITISH MEMBERS OF THE INSTITUTE OF FRANCE.*

THE subjoined address was presented to Monsieur Fallières, the President of the French Republic, at St. James's Palace, on Wednesday, May 27, at 11 a.m.

In the absence of Sir Joseph Hooker, the *doyen* of the British members of the Institute, who was elected in 1866, the address was presented by Sir Norman Lockyer (elected in 1873), with the following words:—

"En l'absence du doyen des membres de l'Institut de France dans ce pays, j'ai l'honneur de vous présenter cette adresse avec le plus profond respect.

"Les sentiments de fraternité ont été maintenus depuis plusieurs siècles entre les littérateurs, les savants et les artistes de la France et de l'Angleterre.

"Nous nous réjouissons qu'à présent tout le monde va suivre notre exemple."

The President made a sympathetic reply, fully acknowledging the importance of science and culture in bringing nations together and cementing their friendship.

The members of the various academies were then presented to the President, who cordially addressed a few words to each.

*To the President of the French Republic.*

Sir,—On the auspicious occasion of your visit to England we, the undersigned Associates and Correspondents of the Institute of France, desire to be permitted to offer to you an expression of our sincere respect. The intellectual pursuits to which that illustrious Institute is consecrated form some of the most potent and enduring bonds that link the nations together in peace and goodwill. As representatives of these pursuits in this country we are proud of our connection with the Institute of France, which has for so long been one of the great centres of culture in the world. We rejoice that the feelings of sympathy and brotherhood which have for centuries been maintained between the cultivators of Literature, Science, and Art in France and Great Britain are now daily spreading more widely and deeply among the peoples of the two countries, and we are sure that your visit cannot but give a powerful stimulus to the progress of this peaceful and beneficent alliance. We desire to express the fervent hope that your tenure of the high office which you hold with such lustre and distinction may long continue to be prosperous.

We trust that you may be pleased to receive the assurance that the people of this country are heartily united in their sentiment of admiration and friendship for the people of France.

We have the honour to subscribe ourselves, with the deepest respect,

Your obedient servants,

1866. Sir Joseph Hooker, G.C.S.I., O.M., C.B. F.R.S. 1900, A.
1873. Sir Norman Lockyer, K.C.B., F.R.S.
1874. Sir William Huggins, K.C.B., O.M., F.R.S.
1878. Whitley Stokes, C.S.I., C.I.E., F.B.A. 1891, A.
1881. Sir Lawrence Alma-Tadema, O.M., R.A. 1891, A.
1883. The Rev. R. Flint, D.D., LL.D.
1887. Sir John Evans, K.C.B., F.R.S.
1890. The Right Hon. Lord Rayleigh, P.C., O.M., Nobel Laureate, P.R.S.
1890. Sir Hubert von Herkomer, C.V.O., R.A. 1896, A.
1890. Sir E. Maunde Thompson, K.C.B., I.S.O. P.B.A.
1891. Sir Archibald Geikie, K.C.B., F.R.S.
1891. The Right Hon. James Bryce, P.C., F.R.S., F.B.A. 1904, A.
1893. A The Right Hon. Lord Lister, P.C., O.M., F.R.S.
1903. Sir Frederick Pollock, Bart., F.B.A.
1903. Sir Henry Roscoe, F.R.S.
1894. R. W. Macbeth, R.A.
1895. Sir William Ramsay, K.C.B., Nobel Laureate, F.R.S.
1896. Sir William M. Christie, K.C.B., F.R.S.
1896. Sir David Gill, K.C.B., F.R.S.
1898. Sir Edward Poynter, Bart., P.R.A.
1899. Sir Edwin Ray Lankester, K.C.B., F.R.S.
1901. A Sir William Q. Orchardson, R.A.
1901. J. S. Sargent, R.A. 1905, A.
1902. J. E. C. Bodley.
1902. The Right Hon. Lord Reay, P.C., G.C.S.I., G.C.I.E., F.B.A. 1906, A.
1903. John H. Lorimer, R.S.A.
1903. W. G. John, A.R.A.
1903. Edward Caird, LL.D., D.C.L.
1904. Stanhope A. Forbes, A.R.A.
1905. Arthur J. Evans, F.R.S., F.B.A.
1905. Sir Francis Seymour Haden, P.R.S.P.E.
1905. Barclay Vincent Head, D.Litt., D.C.L., Ph.D.
1905. Richard Phené Spiers, F.R.I.B.A., F.S.A.
1906. Sir William Crookes, F.R.S.
1907. Sir George Darwin, K.C.B., F.R.S.
1907. The Right Hon. Lord Brassey, G.C.B.
1908. The Right Hon. A. J. Balfour, M.P., F.R.S.
1908. E. A. Abbey, R.A.

The following is a French translation of the Address:—

*A son Excellence, Monsieur Fallières, Président de la République Française.*

Monsieur le Président,—Nous saisissons avec empressement l'occasion de votre visite officielle à Londres pour vous prier, en notre qualité de Membres associés et correspondants de l'Institut de France, de vouloir bien accepter l'expression de nos plus respectueux hommages.

Les Arts et les Sciences au progrès desquels se dévoue l'illustre Institut de France constituent des liens à la fois parmi les plus puissants et les plus durables qui unissent les nations dans le maintien de la paix et de la cordialité. Comme représentants de ces différentes branches de culture intellectuelle en Angleterre, nous sommes heureux et fiers d'être en rapports intimes avec l'Institut de France, depuis si longtemps l'un des grands foyers de lumière du monde entier.

Nous nous réjouissons à la pensée que les sentiments de sympathie et de fraternité qui se sont maintenus depuis plusieurs siècles entre les littérateurs, les savants et les artistes de la France et de la Grande Bretagne s'étendent et se fortifient journellement entre nos deux nations, et nous sommes persuadés que votre visite ne peut manquer de stimuler puissamment le progrès de cette alliance pacifique et bienfaisante.

Nous vous prions, Monsieur le Président, de vouloir bien nous permettre d'ajouter l'expression de notre ferme espoir que votre occupation du poste élevé dont vous remplissez les fonctions avec tant de lustre et de distinction continuera longtemps à être heureuse et prospère; et nous esperons qu'il vous sera agréable de recevoir l'assurance que la nation Britannique est unanime dans ses sentiments d'admiration et d'amitié pour la nation Française.

Nous avons l'honneur d'être avec le plus profond respect,

Monsieur le Président,

Vos très obéissants serviteurs.

The Address, which was beautifully illuminated, had been approved by the President and officers of the Royal Society and the President of the Royal Academy. The organisation of the deputation and the correspondence connected with it were undertaken by the British Science Guild.

## NOTES.

The local secretaries for the Dublin meeting of the British Association desire to direct the attention of officers of the association and members who intend to be present to the urgent necessity of filling up and returning forthwith the post-card sent out with the invitation circular. Many have already done so, but the work of the hospitality subcommittee, which has to be completed months beforehand, and, as everyone knows, is of a delicate and difficult nature, is now at a standstill owing to the fact that information has not been received from a large number of the chief members of the association as to whether they will be accompanied by lady members of their families or not. This information is asked for on the card referred to, which is the only source at the command of the local committee.

A statue of Liebig is to be erected in Darmstadt, where he was born in 1803. The corporation of Darmstadt has contributed 150*l*. towards the expenses.

The death is announced of Dr. R. Chalmers, of the Canadian Geological Survey, at the age of seventy-four years. Dr. Chalmers, says *Science*, joined the survey about twenty-three years ago, and conducted work in Pleistocene geology, especially in his native province of New Brunswick.

At the anniversary meeting of the Linnean Society on Monday the King of Sweden was elected an honorary member of the society. Dr. Dukinfield H. Scott, F.R.S., was elected president in succession to Prof. W. A. Herdman, F.R.S., and Dr. Otto Stapf, F.R.S., was chosen to fill the office of botanical secretary thus vacated by Dr. Scott. The gold medal of the society was presented to the Rev. T. R. R. Stebbing, F.R.S.

A Reuter message states that an International Association for Cancer Research was inaugurated in Berlin on May 23 to promote the investigation of cancer and the care of cancer patients, the collection and publication of international cancer statistics, and the establishment of an international centre of information on all matters concerning cancer research. The association proposes to publish an international technical organ, and to organise international cancer conferences. So far, thirteen States, including all the great Powers except Great Britain, have joined the association, the seat of which will be at Berlin.

The inauguration of the International Institute of Agriculture took place in Rome on May 23 in the presence of the King of Italy, who formally opened the new building for the use of the permanent delegates. The *Times* correspondent reports that the Italian Government was represented by seven ministers and the chief State officers. Thirty foreign delegates, including Sir Thomas Eliot, representing Great Britain, attended, and were entertained at dinner by the King. The new building is the gift of the King of Italy, who also has endowed the institute with an income of 12,000*l*. a year, bringing the total annual income up to 40,000*l*. The international character of the institute is assured by the fact that it is receiving the support of every nation, and nearly all have appointed delegates. It was only in June, 1905, that the conference assembled in Rome at the invitation of the King of Italy to consider the project, and the excellent progress which has been made already augurs well for the permanent success of the institute.

The Royal medals and other awards given annually by the Royal Geographical Society for the encouragement of geographical science and discovery were distributed at the anniversary meeting of the society on Monday. The founder's medal was presented to Lieut. Boyd Alexander, for his African explorations and careful trigonometrical survey of the region between the Benue and Lake Chad. Lieut. Boyd Alexander devoted a considerable time to the exploration of Lake Chad, and added materially to our knowledge of that constantly shifting lake. A careful study was made of the hydrography of the various river systems, the Niger, the Congo, and the Nile, through which the expedition passed. Detailed maps were made of the more unknown parts of the region, such as the Bamingi, Kibali, and the Yei rivers. Much information was gathered concerning the physical features of the region passed through; careful studies were made of several of the types of natives, and important additions were made to our knowledge of the natural history of the extensive region. The patron's medal was awarded to H.S.H. the Prince of Monaco, for his work in oceanography. Among the notable additions to scientific knowledge made on board the *Princess Alice* are:—(1) the results of using the deep-sea traps invented by the Prince, which threw a new light on the life on the floor of the deepest parts of the ocean; (2) successive seasons' exploration on the coast of Spitsbergen and in the adjacent seas; and (3) studies of the conditions of the upper air by means of meteorological kites in mid-Atlantic. Other awards were as follows:—Murchison award to Colonel Delmé-Radcliffe, for his work when as resident in the Nile province of Uganda he mapped the whole province, and for the work which he did afterwards when in charge of the English section of the Anglo-German Boundary Commission, between Victoria Nyanza and Mount Ruwenzori. The Gill memorial to Dr. T. G. Longstaff, for his exploring work in the western Himalayas and Tibet, and especially on his last expedition in the Garhwal Himalayas, when he ascended the summit of Trisul. The Back bequest to Lieut. George Mulock, for his long-continued work, mostly during his own time, in preparing the six sheets of the Antarctic charts, showing the results of the *Discovery* expedition. The Cuthbert Peek grant to Rai Sahib Ram Singh, a native Indian surveyor, who has done excellent surveying work on the expeditions of Captain Deasy, Dr. Stein, Captain Rawling, and Major Ryder.

At the conclusion of a description in part iv. of vol. lxxxix. of the *Zeitschrift für wissenschaftliche Zoologie* of the remarkable land-planarians of the genus Rhynchodemus, Dr. W. E. Bendl, of the University of Gratz, points out that certain curious variations in the secondary genital structures of the members of this and the allied genera appear to be correlated with geographical distribution. In one group the male copulatory organs are found to be of much simpler structure than in a second assemblage, and it appears that while the former type is in the main characteristic of the Oriental and Australasian species, the latter is dominant in the eastern Holarctic and Ethiopian forms.

We have received a copy of an excellent little biographical pamphlet, by Prof. W. May, of Karlsruhe, entitled "Auf Darwin-Spuren," and forming part xiv. of "Gemeinverständliche Darwinistische Vorträge und Abhandlungen," published at Brackwede-i-W. by Dr. W. Breitenbach, the editor. The part before us is illustrated with portraits of Darwin's father and grandfather, and with reproductions of photographs of the Darwin statue at South Kensington, and of the house at Shrewsbury where the great evolutionist was born. Whether by intent or by accident, the fasciculus appears very opportunely in relation to the impending "jubilee" of the reading of the "origin-of-species papers" by Darwin and Wallace at the Linnean Society.

We have been favoured with a copy of a pamphlet (without printer's or publisher's name) describing the laboratory established in 1901 at Sutton Broad, Norfolk, by Messrs. Eustace and Robert Gurney for the study of fresh-water biology, in which it is announced that the gentleman last named will be pleased to arrange for the accommodation of naturalists desirous of working on this branch of research, no charge being made for the use of the laboratory. A considerable amount of work has already been accomplished in connection with the tidal system of the district, and its past and present effects on the fauna of the Broad. The crustaceans, beetles, and dragon-flies, and to a certain extent the rotifers and hydrachnids of the district, have formed the subjects of investigation, but much remains to be done in connection with the molluscs, turbellarians, and protozoans.

From the Entomological Bureau of the U.S. Department of Agriculture we have received Circular No. 99, dealing with nut-weevils, and from the West Virginia University Agricultural Experiment Station Bulletin No. 110, devoted to the grape-vine root-borer. Two species of weevil do considerable damage to chestnuts, of which large quantities are now grown in the States, and various methods of checking the multiplication of these pests are suggested. Hazel-nuts are attacked by an allied, but shorter-bodied and shorter-beaked, weevil. The grape-vine root-borer is one of the clear-winged moths, and a species indigenous to North America, where it doubtless originally infested wild vines. The caterpillars burrow long tunnels in the roots of vines, to which they do very serious damage, for the most part quite unknown to the cultivators. The cultivation of races of vine immune to the attack of root-borers is recommended.

In a recent number of Records of the Indian Museum (vol. i., part iv., No. 23, December, 1907), Captain R. E. Lloyd describes and figures, under the name *Nudiclava monocanthi*, a remarkable new genus and species of hydroids, which has been found parasitic on a fish, *Monocanthus tomentosus*. The hydroid consists of a basal cœnosarcal plate attached to the skin of the fish, and from the basal plates arise the hydranths and the gonophores. The hydranths are entirely devoid of tentacles, and have a peculiar histological structure; thus Nudiclava resembles greatly *Hydrichthys mirus*, described by Fewkes, but differs in the gonophores being sporosacs, while Hydrichthys produces free medusæ. In the Memoirs of the Indian Museum (vol. i., No. 2) Captain Lloyd describes the anatomy of the gigantic marine isopod *Bathynomus giganteus*.

The April number of the *Emu* is illustrated by a reproduction from a photograph of a nest of the brown flycatcher (*Micraeca fascinans*) containing two eggs laid by

Nest and Eggs of Brown Flycatcher, with Egg of Square-tailed Cuckoo. (Nearly natural size.)

the rightful owner, and a third deposited by the square-tailed cuckoo (*Cacomantis variolosus*). The size of the nest admits of only three eggs; and it is stated in the same issue by Mr. E. M. Cornwall that in the case of an allied flycatcher (or "flyeater") and the bronze-cuckoo, the former bird normally lays a clutch of three eggs, but only two of them are found in a nest containing a cuckoo's egg. What becomes of the third egg is not stated. In the case of the nest photographed, the difference between the colour of the cuckoo's and the flycatcher's eggs, as shown in the accompanying reproduction, is very marked, while the small size of both is very noticeable.

The third volume of Notes from the Royal Botanic Garden, Edinburgh, is devoted to a history of the garden and biographies of the principal gardeners from the year

1756. The concluding portion now issued is mainly concerned with William M'Nab, who was deservedly esteemed both for his capabilities as a gardener and for his personality. He was a noted authority on heaths and hard-wooded plants. The papers he published on the planting of hardy evergreens and the cultivation of Cape heaths are printed as an appendix to his biography.

THE list of new garden plants introduced during the past year has been issued in the usual form of an appendix (No. 3) to the *Kew Bulletin* for 1908. The record includes new species of Bulbophyllum and Eria from Malaya and India; species of Lewisia are products of the United States, and a large number of cactus specimens under the genera Echinopsis, Echinocactus, Mamillaria, and Phyllocactus have been introduced from Mexico, Argentina, Paraguay, and other States of South America. Among the small quota from China there occur species of Rhododendron, Viburnum, and Berberis.

WITH the view of making known the results of investigations upon tropical American ferns as they are undertaken in the National Herbarium at Washington, it is proposed to issue a series of studies similar to the series "Studies of Mexican and Central American Plants." The work is being entrusted to Mr. W. R. Maxon, and the first part is published as vol. x., part vii., of Contributions from the United States National Herbarium. The part contains critical notes on uncertain genera and species. The limits of *Asplenium salicifolium* and the identity of *Asplenium rhizophyllum* are discussed. A number of new species are diagnosed, and the new generic name Ananthacorus is suggested for *Pteris angustifolia*.

AN article contributed by Mr. F. Ramaley to the University of Colorado Studies, vol. v., No. 2, describes the plant distribution in the north-east of Latimer County, in Colorado. The altitude varies from five to six thousand feet; the soil of the district is derived from sedimentary rocks, largely Red Sandstone, except in parts where granite rocks occur. The prevailing formation is a scrub of *Cercocarpus latifolius*, dotted in parts with *Pinus scopulorum*; grasses and species of Artemisia clothe the valleys, but along the streams bushes and trees, such as species of Pseudotsuga and Salix, find a congenial habitat. The Cercocarpus scrub grows densely on the sandstone soil, but is almost absent on the granite; lichens and Selaginella, on the contrary, prefer the granite areas.

IN *Man* for May Mr. D. I. Bushnell describes an ancient site at Kimmswick, Missouri, with curious remains of an ancient salt factory. The vessels used are remarkable as having an impression of cloth on the outer surface. It is supposed that a depression was first made in the earth or sand of the size and form of the vessel desired. The hollow was then lined with cloth, over which was spread a thin layer of clay previously mixed with pulverised shell and sufficient water to make it of the proper consistency. When the vessel became dry and was taken from the mould the cloth would be removed, the impression of which, however, would remain on the outer surface. The extensive cemetery adjoining the factory seems to belong to a branch of the Shawnee tribe, who probably made salt on this site.

THE March number of *Buddhism*, the organ of the International Buddhist Society, which advocates the propagation of the faith in the West, contains a remarkable article by Mrs. Rhys Davids on "The Value of Life in Buddhism." The more advanced school of Buddhists have come to see that the current conception of Nirvána as the cessation of sentient existence is a fatal obstacle to the acceptance of the Dharma in Europe. As the writer observes:—"It is hardly conceivable that the West will call such a creed anything but pessimistic, so long as the West retains its peculiar view of life, and its conception of the essential immortality of the self." Hence she proposes to define Nirvána as "the perfected state of the individual mind and heart, emancipation from all taint of lust, ill-will and illusion." She endeavours to show that Buddha, "in judging human individuals capable of realising, now and again, a perfected humanity independently of any transcendental outlook, raised life, or the possibilities of life, to a very high value." The editor, in a very cautious criticism of this theory, seems to prefer to believe that "Buddha and his advanced hearers beheld an interminable series of lives, with Nibbána as the goal." It seems unlikely that this attempt to put new wine into old bottles will be accepted by the orthodox thinkers of the East. But in view of the current belief in the immobility of eastern faiths, the new development is certainly interesting.

MR. F. COHEN, of Bonn, has published a beautiful contoured map of the Eifel, including Aix-la-Chapelle, Coblentz, and Trèves, on the scale of 1 : 200,000, prepared from the Government Survey by Dr. H. Rauff. The height-zones are shown in clear shades of colour, the contours being drawn at every fifty metres. For geographers and cyclists, who may often be happily combined, this large sheet, published at 3 marks, is a really notable achievement.

PROF. H. POTONIÉ has issued a fourth and enlarged edition of his brochure entitled "Die Entstehung der Steinkohle" (Borntraeger, 1907, price 4 marks). This is illustrated in the best sense by a number of landscape views of actual vegetation in swamps, bogs, and forests, with examples of stems found *in situ* in Coal-measures. A strong case is made out for the theory of the production of coal-seams in place and not by flotation, and stress is laid on deposits of "sapropelite," from the decay of various water-loving organisms and their excrement. A form of carbonaceous rock results which in turn provides petroleum. All who have to do with coal may read this little book with pleasure, and they will be especially grateful for the care with which the illustrations have been brought together and reproduced.

THE results of the meteorological observations made at Mount Tsukuba (Japan) during 1903 have recently been received; at the peak station (869·5 metres) and at the base hourly observations are given, at the middle station (240 metres) for every two hours. The volume contains an interesting discussion by Mr. T. Okada of a typhoon that swept over the eastern part of Japan on September 28, 1902, with a violence that had not been experienced for many years. An interesting fact is that the storm centre passed very near Mount Tsukuba (lat. 36° 12′ N., long. 140° 5′ E., approximately), so that the atmospheric condition at the summit and base stations could be determined. On the same day another violent cyclone appeared over the western part of the islands.

THE *Denkschriften* of the Vienna Academy of Sciences, vol. lxxxi., contain a very valuable contribution to the meteorology of west Turkestan, compiled (at the suggestion of Dr. J. Hann) by Heinz v. Ficker from the Russian meteorological year-books and other sources, and based on observations between 1894 and 1903 at seventeen stations. The area, which embraces $8\frac{1}{2}°$ of latitude and

$17\frac{1}{2}°$ of longitude, and differences of altitude amounting to 3600 metres, is subject to great contrasts of climate, *e.g.* at Pamirski Post, in the south-east, the mean yearly temperature is 29°·8 F., and at Termez, in the south, 63°·9; the mean yearly variation (difference of warmest and coldest months) is 68°·2, at Kasalinsk, in the north-west, and 40°·9, at Prschewalsk, in the north-east. The whole country has a very small rainfall, averaging from about 5 inches on the Steppes to $14\frac{1}{2}$ inches in the districts of the Naryn and Lake Issykul. The author states, with reference to the cultivation of the land, that the small rainfall and rapid evaporation give rise to the gravest fears for the future of the country.

Dr. A. Stock announces in part ii. of the *Verhandlungen der deutschen physikalischen Gesellschaft* for 1908 that he has succeeded in producing a material which, while porous to air and other gases, will not allow mercury to pass through it at pressures less than 1 atmosphere. It is composed mainly of clay, water-glass, and gum burnt together, and can be substituted for the taps and other appliances used in the manipulation of gases. The material withstands acids and boiling water, can be fused directly to glass, and is about five times as porous as that used by Dr. K. Pritz for the same purpose two years ago.

In France the Société d'Encouragement granted a subvention for a research on the gases occluded in steels, and the results of the work, by Dr. G. Belloc, of the University of Caen, are published in the current issue of the Bulletin (vol. cx., No. 4) of the society. The gases, he finds, consist of mixtures of carbon dioxide, carbonic oxide, hydrogen, and nitrogen, and the liberation of the gases is in intimate relation with the critical points of iron. Carbon dioxide is liberated first at about 550° C., and forms the great bulk of the volume present. Nitrogen begins to appear at 550°. More gases are given off by the steel taken from the centre of an ingot than from samples nearer the surface.

The *Physical Review* for April contains a study of the changes of the electrical resistance of selenium cells by Messrs. F. C. Brown and J. Stebbins, of the University of Illinois. They find that pressure diminishes the resistance at a rate nearly constant up to about 400 kilos. per sq. cm., and that the cells are somewhat less sensitive to light at high than at low pressures. Increase of temperature in the neighbourhood of 20° C. produces a rapid decrease of resistance, which becomes less marked as the temperature gets higher. The sensitiveness to light decreases as the temperature rises, and appears to be a function of the resistance of the cell, whether that resistance is determined by the temperature, pressure, or illumination of the cell. Radium and hydrogen peroxide both decrease the resistance of a cell to a remarkable extent.

Messrs. Macmillan and Co., Ltd., have published the forty-fifth annual issue of "The Statesman's Year-book," that for 1908. Its character is described excellently by its subtitle—"Statistical and Historical Annual of the States of the World for the Year." The volume has been enlarged again; more space is devoted to the British Empire and the United States. An account of the changes in the organisation of the British Army has been included, and the returns of the recent French census of 1906 are given. Some thirty pages of additions and corrections contain the most recent available statistics, among others those of public education in England and Wales. The maps and diagrams are, as usual, a very attractive feature. Three diagrams deal in a luminous manner with important matters in connection with the British Navy, and some interesting comparisons with the naval strength of other countries are shown graphically. It would be valuable and instructive if next year the editor, Dr. J. Scott Keltie, could provide similar diagrams comparing the United Kingdom with Germany, the United States, and other great countries, so far as the provision of higher education is concerned. We know of no subject in which statesmen stand more in need of instruction; and we are sure that a graphical comparison of the expenditure on higher education and scientific research, of the percentage of the population receiving higher technical instruction, and similar matters would show that while we apply the two-power standard to the arts of war, we are behind other progressive nations in the provision made for the arts of peace through higher education and science.

A fourth edition of Prof. E. Hammer's "Der logarithmische Rechenschieber und sein Gebrauch" has been published by Mr. Konrad Wittwer, of Stuttgart. The volume deals with methods of using logarithms and the slide rule, and their application to various forms of calculation. No tables are provided. The price of the book is one mark.

We are glad to see a column devoted to science of the week in the *Standard of Empire*, the first number of which appeared on Saturday last. The new periodical, which is published at the *Standard* office, will appear as a gratis supplement every Thursday in that newspaper, and will also be issued separately as a weekly journal devoted to Imperial affairs.

We have received from Mr. Robert Sutton, 43 The Exchange, Southwark, S.E., the fourth part of the first volume of Dr. E. Howard Adye's "Studies in Micropetrography." This fasciculus contains pages 29–36 of the first volume, and two full-page plates. The rocks dealt with are ophitic diabase, andesitic dolerite, fine olivine-basalt, and ophitic olivine-dolerite.

Messrs. A. and C. Black are publishing a second edition of "Studies in Fossil Botany," by Dr. D. H. Scott, F.R.S. The work, the first edition of which was reviewed in Nature of November 15, 1900 (vol. lxiii., p. 53), will in future appear in two volumes. The first, dealing with the Pteridophyta, is now ready, and its price is 6*s.* net; the second volume will be published, it is expected, next autumn, when we propose to review the complete work.

Messrs. Cassell and Co., Ltd., have commenced the publication, in twenty-four fortnightly parts, price 7*d.* net each, of "The Nature Book." The work is to be a popular description by pen and camera of the beauties of outdoor nature. Among numerous contributors we notice the names of Messrs. Walter Crane, Richard and Cherry Kearton, and Dr. W. J. S. Lockyer. The first part reaches a high standard of excellence. The letterpress is interesting and accurate, while the illustrations are abundant and beautiful. The publication should secure a wide popularity, and prove of real service to teachers of nature-study.

The first volume of the fifth edition of Prof. Wundt's "Grundzüge der physiologischen Psychologie" appeared in 1902, and was noticed in Nature of November 6, 1902 (vol. lxvii., p. 2). The second and third volumes of the same edition were reviewed in 1905, with Prof. Titchener's translation of the work (vol. lxxi., p. 529). The first volume of the sixth revised edition of this elaborate work has now been received from the publisher, Mr. W. Engelmann, Leipzig. Nearly two hundred pages have been added, the increase being necessitated by the rapid growth of experimental or physiological psychology during the past few years. The character of the work remains the same, and has been sufficiently described in reviews of earlier editions. The price of the present volume is thirteen marks.

## OUR ASTRONOMICAL COLUMN.

DANIEL'S COMET, 1907*d*.—A continuation of Herr H. H. Kritzinger's ephemeris for Daniel's comet appears in No. 4245 of the *Astronomische Nachrichten* (p. 345, April 29). From this ephemeris we see that the comet is now apparently travelling very slowly through the constellation Virgo, nearly parallel to, and some 15′ south of, the equator. Its positions on June 1 and 13 will be $\alpha=13h.\ 52 \cdot 1m.$, $\delta=-0^\circ\ 14' \cdot 3$, and $\alpha=13h.\ 48 \cdot 1m.$, $\delta=-0^\circ\ 20' \cdot 2$, respectively. The comet is now a little brighter than the twelfth magnitude, and crosses the meridian about 9.30 p.m.

SPECTROSCOPIC BINARIES.—For some time past the observers at the Dominion Observatory, Ottawa, have been endeavouring to complete their set of observations of the spectroscopic binary $\iota$ Orionis by obtaining spectrograms at a critical part of the velocity curve where it changes its form rapidly. According to a note in No. 2, vol. ii., of the Journal of the Royal Astronomical Society of Canada (p. 106, March-April), the necessary spectrograms were secured at the end of January. The following principal elements have been calculated from measurements of 107 plates:—period = 29·136 days, eccentricity = 0·75, longitude of the apse 110°, projected length of semi-major axis = 29,680,000 km., and velocity of the system = +20·7 km.

Elements for $\psi$ Orionis, of which the radial velocity has a remarkably short period, have also been obtained; they are:—period = 2·5259 days, $e=0 \cdot 063$, $\omega=186^\circ$, and $a \sin i =$ 5,103,000 km.

Mr. Harper has recently discovered that the star $\delta$ Herculis has a variable radial velocity with a fairly wide range; this star has therefore been added to the observing list at Ottawa.

RECENT OBSERVATIONS OF JUPITER.—Some interesting observations of Jupiter were reported to the March meeting of the British Astronomical Association by the Rev. T. E. R. Phillips, who directed attention to the fact that the great south tropical disturbance was once more passing the great Red Spot. The dark material of the disturbance was observed to be passing round the south side of the Red Spot by the south temperate belt, leaving a sharply defined oval in which the Red Spot lay; the latter feature was very difficult to see, and appeared at times to be distorted and irregular in form, as though clouds were passing over it. Since the beginning of the apparition the disturbance has increased considerably in length, from about 60° in September to 115° at the end of January. The rotation period of the Red Spot was less during the earlier part of the apparition, but the diminution was not so marked as it was during the conjunction of 1906, when it amounted to 14° between April and August. At each conjunction of these two features, since the first appearance of the south tropical disturbance in 1901, the Red Spot has, for the time being, appeared to be pushed forward (the *Observatory*, May, No. 396, p. 196).

DOUBLE-STAR OBSERVERS.—In continuing his series of articles on double-star observers in the May *Observatory* (No. 396, p. 205), Mr. Lewis gives a very interesting account of the work performed by Baron Dembowski between 1852 and 1878. With a telescope of 5 inches aperture, and fitted with neither position circle nor driving clock, Dembowski commenced a revision of the brighter pairs given in the "Mensuræ Micrometricæ," and did most excellent work. After mentioning the double-star work of Schiaparelli and other observers, Mr. Lewis proceeds to the consideration of what he calls the third period of double-star astronomy, which began when Burnham submitted a catalogue of eighty-one new double stars to the Royal Astronomical Society in 1873; all these doubles had been observed with a 6-inch refractor mounted in Burnham's back yard. In 1900 this same observer published a catalogue of 1290 doubles discovered by himself between 1871 and 1899. Mr. Lewis also gives a long list of observers of this third period, and the sizes of the instruments with which they worked.

In the note on the relative accuracy of various double-star workers, which appeared in these columns last week, the mean value given in the last line should, obviously, be $0'' \cdot 0698$, and not $0'' \cdot 698$ as printed.

THE COLOUR FILTER AND ISOCHROMATIC PLATE IN ASTRONOMICAL PHOTOGRAPHY.—An important paper by Mr. R. J. Wallace, on the function of a colour filter and "isochromatic" plate in astronomical photography, appears as a reprint from the *Astrophysical Journal* for March. Mr. Wallace discusses at length the use of various filters and stained plates, and shows, by reproductions of some of his photographs taken at the Yerkes Observatory, the immense gain in definition resulting from such use.

In the course of his discussion Mr. Wallace also refers to the results recently published by Prof. Lowell in his paper on the sharpening of celestial photographic images, and states a number of points whereon he disagrees with the conclusions arrived at by Prof. Lowell.

A NEW ASTRONOMICAL JOURNAL.—The first number of a new journal, printed in Japanese characters, has just appeared under the title of the *Astronomical Herald*, and is published by the Astronomical Society of Japan. This first number is dated April, and contains, among other articles, a note on sun-spots by Mr. S. Hirayama, and one on ancient astronomy.

## ALTERNATE CURRENT MEASUREMENT.

THE ordinary dynamometer is as well adapted for direct as for alternate current measurements; but while it is generally regarded as the best available instrument for alternate currents, its use with direct currents is almost restricted to standard instruments of the ampere balance type. This is due to the immensely greater sensitiveness obtainable with direct current instruments constructed on the heterostatic principle, as exemplified in galvanometers with permanently magnetised needles or magnets. The latter instruments, due originally to Kelvin and Maxwell, and first developed commercially by Ayrton and Perry, have been brought to a high state of perfection in recent years, with the result that ordinary measurements on direct current circuits are much more precise and satisfactory than those on alternate current circuits.

The only likely way at present of improving alternate current instruments is to use iron-cored electromagnets to increase the strength of the field acting on the moving system. The well-known difficulties due to the varying permeability, hysteresis, &c., of the iron cannot be overcome, but may be entirely avoided by exciting the electromagnet in shunt.

The excitation of an electromagnet can be governed either by controlling the current through the exciting coil or by controlling the voltage applied to the winding. On direct current circuits the two methods are identical owing to the operation of Ohm's law, but with alternate currents the two modes of control lead to widely different results if the resistance of the winding is made small compared with the impedance. With current control, the magnetism produced depends on the properties of the core, but is independent of the resistance of the winding. The reverse is true of the voltage controlled magnet, for, if this is suitably designed, the magnetic flux is connected with the applied voltage by a strict mathematical law not dependent on the physical properties of the core, except for a small correction term due to the resistance of the winding. The shunt magnet in another way contrasts sharply with the series magnet. In each case the strength of the magnet is increased by diminishing the air gap, but the smaller this is made the more accurate the shunt magnet becomes and the less accurate the series magnet. The field due to the shunt magnet is not in phase with the applied voltage, so that special means must be used to supply the moving coil of the instrument with a suitable current if the deflection is to indicate truly the quantity to be tested. But this difficulty, it is found, can readily be overcome. All measurements with alternate currents relate to mean values. It is not necessary to make the instantaneous value of the torque exerted on the moving system of the instrument a measure of the simultaneous value of the quantity tested, as, for instance, is the case with ordinary dynamometers. All that is needed is proportionality between the mean values. With the aid of this principle it can be shown that the shunt magnet offers for instrument purposes great advantages, one of these being that the density of the air-gap flux, without loss of accuracy, can be increased to a value far exceeding that obtainable in permanent magnet instruments.

The ordinary modes of analysis used for the solution of alternate current problems rest upon several convenient but inaccurate assumptions, such as sine law wave form, proportionality of magnetic flux to magnetising current, &c. Such methods can be used to give an approximate explanation of known results, but are not adapted to predict precisely the action of a new type of instrument in terms of measured data relating to its parts. In a paper read before the Royal Society[1] on January 16, a simple form of analysis, previously pointed out by the present writer, is further developed. This method is free from

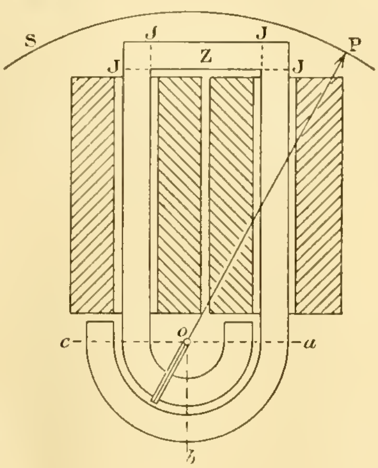



FIG. 1.

assumptions such as those mentioned. It rests upon the theorem that each one of a number of known cyclic quantities, however different these may be in wave form, can be expressed as a linear function of an equal number of other cyclic quantities, the latter being such that the mean square of each is unity, and the mean product of any two is zero. This theorem leads naturally to a vector method of representation, which in many cases closely approximates to that usually adopted for alternate current investigations, but there is the important difference that when the results obtained are independent of assumptions such as sine law wave form this fact can be proved, while if such independence does not hold good a superior limit can be found to the error involved in results obtained by the ordinary method.

One of the instruments of which the behaviour has been investigated theoretically and fully confirmed experimentally is illustrated in Fig. 1. The magnetic circuit consists of a block of thin iron stampings shaped so as to have only one narrow air gap, the section of which is increased by suitably extending the poles. The field windings are shown in section, and are liberally supplied with copper. By this construction the ratio of resistance to impedance is made small. The moving coil is rectangular, one side turning in the air gap, the opposite side acting as an axis perpendicular to the figure, and shown at *o*. The instrument becomes a voltmeter if the moving coil is placed in series with a condenser across the voltage applied to the field coil. It becomes a wattmeter if the main current is passed through an induction coil the secondary of which contains a large resistance and the moving coil. If the resistance of the field coil were zero, the flux through the core would simply depend on the applied voltage, whatever the magnetic properties of the core; and if this coil were short-circuited the core flux could not be varied. The chief points to be investigated were the effect of the actual resistance of the field coil, the influence of the E.M.F. induced by the field in the moving coil circuit, and the precise meaning and influence of the self-inductance of the moving coil. Exact formulæ have been established and verified for all these effects, some of which may be illustrated by the following tests. If the field coil be open-circuited and a current be passed through the moving coil, this will turn so as to enclose the greatest flux, but this position will not be *oc* because of the portion of the flux crossing the air gap twice, this part being greatest for the position *ob*. For feeble currents the resulting position will be near *ob*, but will tend to approach *oc* for larger currents, owing to the corresponding increase in the permeability of the core. If, however, the field coil be short-circuited, an alternating current through the moving coil will invariably turn it to the position *ob*, because such current cannot produce a flux through the long limbs of the magnet. If the field coil be excited by an alternating voltage and the moving coil circuit be closed through a small resistance, this coil, owing to its self-inductance, will turn to *oa* so as to enclose the minimum flux, while if under the same conditions the moving coil circuit be closed through a condenser, the coil will turn to *oc* so as to enclose the maximum flux.

A thorough analysis of these effects, confirmed by actual tests, shows that the instrument can be so constructed that for most purposes its errors are negligibly small, and also that it is possible to eliminate precisely these errors for any specified frequency by using a special winding round the magnet with its ends joined up to a condenser the capacity of which is determined by the frequency and the winding. None of the errors arise from the variable magnetic properties of the core. In connection with alternating current work, the voltage-controlled magnetic field thus offers great advantages for investigating purposes.

W. E. SUMPNER.

[1] "Alternate Current Measurement." By Dr. W. E. Sumpner. (Communicated by Prof. Perry, F.R.S.)

## NEW LIGHTS ON THE ANTHROPOLOGY OF CALIFORNIA.

THE anthropological department of the University of California, thanks to Mrs. Hearst's munificent endowment, is able to issue a further series of studies on the native races of that State. The most voluminous contribution is that of Mr. S. A. Barrett on the "Ethno-geography of the Pomo and Neighbouring Indians," a group of tribes numbering at present about 1000 souls, and occupying the region known to geographers as the Coast Range Mountains immediately north of San Francisco Bay, and running eastward to the Sacramento River. These people are now partially civilised, and support themselves by farming and labour. But sufficient is known of their primitive condition to show that they had no totemic clans or groups, and that their tribal organisation was weak, there being no chief in the commonly accepted sense of the term. There was a sort of council of minor chiefs presided over by a chief captain, whose authority was strictly limited, and who was elected by the community. The inferior chiefs, on the other hand, held their offices by hereditary right, and the succession passed from one incumbent to the family of that sister who was nearest to him in age, kinship and descent being in the female line.

In regard to culture, these people fall into three divisions:—the ocean tribes, who depended for food upon the fish and molluscs which abounded in the sea, and derived the material for their food and clothing from the redwood forests of the coastal districts; secondly, the valley tribes, who occupied in severe weather round grass-thatched houses, while during the summer they wandered along the streams and lived in temporary brush shelters, but used no canoes, as the rivers are of inconsiderable volume; lastly, the tribes of the inner lake region, who built elliptical huts thatched with the tule rush, which also supplied them with materials for nets, mats, and slings with which they killed water-fowl, using for the purpose of fishing canoe-shaped rafts of the tule. The materials for the study of this civilisation now extinct are found in the ancient village sites which have been carefully examined by Mr. Barrett. The greater part of his elaborate report is occupied by a survey of the tribal dialects, which adds largely to the information recorded by Schoolcraft, Powell, Bancroft, and others. In another and less elaborate report Messrs. S. A. Barrett and A. L. Kroeber give an account of the Miwok tribe.

Of more general interest and importance is the investigation conducted by Mr. W. J. Sinclair into the question of the existence of relics of prehistoric man in the auriferous gravels of the Sierra Nevada. The evidence of the early existence of man in California has been hitherto almost entirely based on the well-known report issued in 1880 by Prof. J. D. Whitney in the course of the geological survey of the State. The present inquiry has been devoted to a further investigation of the sites from which the human remains and objects alleged to be the work of man are said to have been derived. The result is seriously disconcerting to those who have relied on the evidence collected by Whitney. Mr. Sinclair points out that, though these gravels and the intercalated volcanic outflows are admittedly of various geological periods, Whitney made no attempt to indicate from which series of gravels the relics were obtained. In the case of the discoveries made in mines worked by hydraulic machinery the provenance of the vast majority of objects can no longer be verified, and there is good reason to suspect that many, if not all, the specimens have been washed down from modern Indian village sites situated on bluffs overhanging the pits, which were disintegrated by the powerful water currents. Mr. Sinclair reviews in detail all the more remarkable "finds" in this region. One large mortar is said to have been found in association with "a small oval tablet of dark coloured slate with a melon and leaf carved in bas-relief." But it exhibits no signs of wear from gravel friction; the scratches are all recent defacements, and the carving is said to show very evident traces of a steel knife-blade.

Special attention is naturally given to the Calaveras skull immortalised by Bret Harte, which is now a cherished possession of the Harvard Museum. Mr. Sinclair asserts that the substance adhering to it is not a gravel, but a cave breccia, and that the skull was not obtained in the gravels beneath the rhyolite, or from any other gravel of the rhyolitic epoch, none of which exhibits any trace of the stalagmitic cementation which has been recognised in the skull matrix. He suggests that the skull was derived from a comparatively modern Indian cave interment. If, he adds, man of a fairly high developed type was in existence during the deposition of these gravels, he must have been "a contemporary of the three-toed horse and other primitive forms of the late Miocene and early Pliocene, a thesis to which all geological and biological evidence is opposed." His conclusion is that the evidence is insufficient to prove the presence of the remains of men in the auriferous gravels; that there have been abundant opportunities for such relics to be accidentally mixed with these gravels; and that the local geological conditions render it improbable that such implements and bones have been found in the assumed sites.

It would be premature to attempt to criticise this important report in detail. Doubtless those authorities who assert the genuineness of these relics will not allow the case to go by default. English anthropologists have always adopted an attitude of reserve in relation to the Calaveras skull. If the question of the antiquity of the human race depended on the authenticity of these Californian discoveries, the position would perhaps be serious. But even if Mr. Sinclair's indictment survives the criticism to which it is inevitable that it must be exposed, the abundant evidence from other unquestioned sources which now exists renders a challenge of one set of relics a matter of little importance. Whatever may be the result of the controversy, the necessity of caution in dealing with evidence which has been collected without rigid scientific supervision is sufficiently obvious.

## *METEORIC PHENOMENA IN JUNE.*

In June there are few meteors seen which leave streaks. Possibly the twilight is responsible for this; it must partially be so, but I do not think that it will wholly account for the seeming rarity of meteors of the same type as the August Perseids or November Leonids.

Yet there are a few noticed by vigilant observers, and especially in the morning hours. These are directed from radiants in Pisces, Andromeda, Aries, Perseus, and other constellations in the same general region of the sky. There are the $\alpha$–$\beta$ Perseids, $\delta$ Cassiopeids, $\pi$, $\mu$, and $\gamma$ Andromedids, $\beta$ Triangulids, $\alpha$ Arietids, $\beta$ and $\epsilon$ Piscids, and many others. In 1887 I saw several fine streak-leaving meteors from a radiant near the position of the August Perseids at about $\eta$ Persei. All the centres referred to, however, stand in need of corroboration, as they are supported on very slender evidence indeed.

Fireballs are not uncommon to June, though few real paths appear to have been hitherto determined in this month.

When we have such excellent atmospheric conditions as prevailed in June, 1887, it is possible to discern a large number of showers. Some of these are directed from places south of the equator; for instance, there are radiants at $252^\circ-21^\circ$, $269^\circ-24^\circ$, $283^\circ-13^\circ$, $305^\circ-12^\circ$, &c.

Occasionally there are some late Virginids and Serpentids noticed in June, and a sprinkling of Ursa Majorids will be recorded by the careful observer.

The weather usually prevailing is excellent, and the sky, though light, is attractive. The writer has often been struck with the prominent aspect of the Milky Way on midsummer nights. It stretches nearly overhead, and the rich regions in Cassiopeia, Cepheus, and Cygnus are often beautifully displayed at this season of the year, notwithstanding the lack of suitable darkness.

W. F. Denning.

## *VISION AND COLOUR-VISION.*

The difference in physiological effect between incident and reflected light is a commonplace to those who have investigated the influence of surroundings on sensitive animals. The *influence du fond* is a function of the altered light reflected from these surroundings upon the eyes or skin of animals capable of assuming variable coloration. The direct incident light has little or no effect in producing the result.

In a series of papers (*Zeit. f. Augenheilkunde*, Bd. xvi., pp. 448–463; *Wiener medezinische Wochenschrift*, No. 46, 1906, No. 48, 1907) Prof. Raehlmann asserts that the light perceived by vertebrates is reflected from the plane separating the outer laminated limb of the rods and cones into the inner homogeneous limb of the same. He now claims that colour-vision is due to the reflected light setting up "stationary waves" in the inner limb of these retinal elements. To support this view he proceeds to show from recent work that if a Lippmann gelatin film (placed between a mirror and a source of light) be exposed to different parts of the spectrum, and then cut into microscopic sections and examined under a high power, the substance of the film is seen to be traversed by zones of black granules separated by colourless intervals, the interspaces equalling the wave-length of the light used, and, therefore, whilst perceptible in the case of red and yellow light, are so crowded together in green and blue light as to be almost continuous. This result is claimed by Prof. Raehlmann as confirmatory evidence of the truth of his hypothesis. The sensitive film is represented by the morphologically inner portion of the rod or cone, the mirror by the membrane separating this from the outer refractive portion, and the case would be complete if any arrangement of black and colourless zones comparable to that set up in the film could be discovered in the inner portion of the cone, but though Prof. Raehlmann has used the ultra-microscope after a given monochromatic exposure, he can discover nothing in the inner cone-limb but a perfectly uniform granulation, and though the length of the cone is known to vary with that of the light-waves used, yet he has not been able to correlate the somewhat different appearance of the granulation in the case of cones exposed to red and blue light with the qualities of the light. This argument from Lippmann's direct colour photography, therefore, is at present unconvincing in its most essential feature.

The second argument in support of the view that colour arises from "stationary waves" set up in the inner segments of the rods and cones is the ready explanation it affords of colour-blindness. On the usual theory that light traverses the outer dioptric limb of the rods and cones and is arrested by the retinal pigment, the origin, and especially the variations of the colour-sense, are difficult to explain, even with the aid of the retinal purple. Prof. Raehlmann, however, has no difficulty in pointing out that disturbance of the reflecting power of the outer rod-limb, such as might readily ensue without causing loss of sharpness of sight, would cause variation and even loss of colour-vision, whilst the much commoner reverse condition would be due to dislocation of the rods by choroidal or pigmentary disturbances from a vertical into an oblique position such as is found normally at the weak-sighted periphery of the eye. Other phenomena of vision—adaptation, the dazzling effect of contrast, after-images, and the interesting structural variations shown in the rods of animal retinas (for example, the coloured globules of many birds, the retina of deep-sea cephalopods)—are also touched upon, and an attempt is made to show that on this hypothesis a fuller explanation may now be given than has hitherto been possible. Direct proof of this view, however, has not yet been obtained, and the analogical or indirect evidence advanced in support of it cannot yet be said to be of a convincing nature.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

Cambridge.—On the occasion of the installation of the Chancellor on June 17 it is proposed to confer degrees upon the following, among others:—Hon. C. Algernon Parsons, C.B., F.R.S., Sir Andrew Noble, Bart., K.C.B., F.R.S., Sir William Crookes, F.R.S., Prof. Horace Lamb, F.R.S., and Prof. G. D. Liveing, F.R.S. It is understood that, according to precedent, the new Chancellor has nominated the recipients of the honorary degrees which will be conferred at his installation.

Dr. Guillemard, Dr. Haddon, and Mr. H. Y. Oldham, of King's College, have been nominated to represent the University at the International Congress of Geography to be held at Geneva next July.

The special board for mathematics has nominated Mr. H. F. Newall, of Trinity College, as a member of the board of electors to the Plumian professorship of astronomy, and the special board for physics and chemistry has nominated Dr. W. N. Shaw as a member of the board of electors to the professorship of mechanism and applied sciences.

The Vice-Chancellor announces that he has received from Prof. Liveing an intimation of his intention to resign the professorship of chemistry an Saturday, June 20.

Edinburgh.—Prof. Crum Brown will resign the chair of chemistry on July 25. Applications for the chair, the patronage of which is vested in the curators, should be sent, with relative testimonials, on or before July 4, to Mr. R. Herbert Johnston, 4 Albyn Place, Edinburgh.

Leeds.—Prof. W. H. Bragg, F.R.S., professor of mathematics and physics in the University of Adelaide since 1886, has been appointed to succeed Prof. Stroud in the Cavendish chair of physics. Prof. Bragg will enter upon his duties at Leeds next February.

Oxford.—Mr. C. F. Jenkin has been elected to the newly constituted professorship of engineering science.

Mr. Benjamin Kidd will deliver the Herbert Spencer lecture on Friday, May 29, at 4 p.m., in the Sheldonian Theatre, the subject being "Individualism and After."

Dr. Joseph F. Payne, hon. fellow of Magdalen College, has been appointed by the delegates of the common university fund to deliver a course of six lectures in the next academic year on the history of medicine, dealing specially with Greek medicine.

Prof. E. B. Poulton and Mr. A. H. Church have been appointed to represent the University on the occasion of the Linnean Society's celebration of the fiftieth anniversary of the reading of the Darwin-Wallace memoir on the origin of species.

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Mr. J. P. Griffith, Rathmines Castle, Dublin, has just contributed 100*l.* towards the new buildings of the North Wales University College.

The Association of Technical Institutions has awarded the prize of 25*l.* for the best essay on "The Bearing of Technical Education on Industrial Progress" to Dr. John Ryan, Milltown, co. Dublin, and the prize of the same amount for the best essay on "The Bearing of Technical Education on Agriculture and Industries of a Rural Character" to Mr. Edgar Chamberlain, Municipal Technical School, Lincoln.

Messrs. Swan Sonnenschein and Co., Ltd., have now published "The Girls' School Year-book" for the year April, 1908, to April, 1909. This is the third year of publication of a very useful work of reference. A hundred and thirty public secondary schools for girls in different parts of England and Wales are described in some detail, and a fairly complete list of similar schools in the United Kingdom is provided. It is not always easy to see the reasons for the choice of schools receiving extended treatment, but the year-book is still young, and the editors will probably extend their selection in future issues. The second part of the volume deals chiefly with careers for girls, but provides other useful information also. The book is certainly gratifying evidence of the improvement which has been accomplished in the education of girls during recent years, and it is satisfactory to notice that it is proposed in next year's issue to deal with instruction in domestic science and housecraft, for it is in this direction that there is real need of experiment and observation if our girls' schools are to be successful in preparing their pupils for one of the most important parts of a woman's life.

We learn from the *Pioneer Mail* that a letter has been sent by the secretary of the Government Education Department to the registrar of the University of Bombay stating that the Governor in Council has had under consideration the nature of the provision at present made in Government colleges affiliated to the Bombay University for the teaching of science. The committee appointed by the syndicate of the University in 1906 to inspect these colleges indicated many points in which the instruction in chemistry, physics, and biology could be improved. The letter points out that it is necessary to meet the requirements of two distinct classes of students—those who specialise in science with the view of making it their life work, and those who take an elementary course to qualify them in part for a degree in arts, or for admission to the medical profession. It is proposed to concentrate the higher teaching of science in the College of Science at Poona, which will be equipped thoroughly for the purpose. Steps have been taken to obtain a full staff of highly qualified professors, and when the college is in full working order it will afford facilities for the study of science such as have hitherto been unattainable in Bombay. For the second class of students it is proposed to provide a laboratory in Bombay at which students from different colleges may pass through a course of elementary science. A similar course would be provided at the College of Science for Poona students, and for the present the science departments of Gujarat and Sind Arts Colleges would be retained. This elementary course will consist almost entirely of practical work, and it is hoped in this way to supply a deficiency in the ordinary course of study of Indian students by providing a training in observation and the accurate recording of facts.

The Scotch Education Department is publishing at short intervals memoranda on the teaching of various school subjects. The teaching of English, arithmetic, languages, drawing, history, and, most recently, nature-study and science, have been dealt with in this way. The sixth memorandum (Cd. 4024) is divided into two sections, concerned with nature-study and science respectively. Nature-study as here described is a very comprehensive branch of knowledge, related in its various aspects with many other subjects, designed primarily, as the introduction to the Blue-book points out, to overcome the divorce between school and home life, which is nowadays a serious defect of education. Nature-study justifies its place in the curriculum only when it brings the pupils into direct contact with natural objects and phenomena, and develops in their minds habits of correct observation and intelligent discrimination. The guidance provided in the memorandum is practical, and preeminently designed to assist teachers, so that the pupils may derive from these lessons the advantages the study can ensure when rightly pursued. School gardens, excursions, collections, calendars, weather observations, and the care of animals, are some of the subjects selected for treatment, and the teachers who work in the spirit of the hints and suggestions which enrich these pages will have no reason to fear failure to develop in their pupils open-eyed interest in nature. An appendix by Prof. J. Arthur Thomson shows teachers in detail how the subject may be studied seasonally, and the difficulty of obtaining material obviated. The second section of the memorandum explains how the work in nature-study should develop later in the curriculum into a more formal study of experimental science, with the object of encouraging the habit and spirit of accurate investigation. Individual work on the part of the pupil is insisted upon, and the importance is pointed out of truthful and clear records of results. Outlines of work are put forward as indicating suitable courses of study for an intermediate school devoting three hours a week, in two equal periods, to the subject, as well as for higher schools. It is satisfactory to find it laid down that the value of the work will depend upon its spirit and method, and upon the power of initiative and self-reliance developed in the pupils, rather than upon the amount of examinable knowledge acquired.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, February 20.—"On the Osmotic Pressure of Compressible Solutions of any Degree of Concentration. Part ii. Cases in which both Solvent and Solute are Volatile." By Prof. A. W. **Porter**. Communicated by Prof. F. T. Trouton, F.R.S.

In a former paper (see NATURE, September 5, 1907, vol. lxxvi., p. 487) the author found an exact relation between vapour pressures and osmotic pressure in the usual case in which the solute may be taken as involatile. The case now considered is the more general one, in which both solvent and solute are volatile.

The author has considered several cases in which the vapour pressure is changed, and found that in each case it is only necessary to know the partial pressure of the pure solvent the vapour of which is referred to in order to calculate what the change in the vapour pressure amounts to. The same method might presumably be applied to other cases also, such as magnetisation, &c.

March 19.—"On Vapour Pressure and Osmotic Pressure of Strong Solutions." By Prof. H. L. **Callendar**, F.R.S.

The foundation of the vapour-pressure theory of solutions laid down in this paper is the assumption of a simple relation between the vapour pressure and the molecular constitution of the solution. That there should be a simple relation of this kind appears extremely probable when we consider that the concentration of the vapour phase in the solutions here examined is very small, and that such relations generally take a very simple form at extreme dilution. That such a relation should serve as a key to many of the phenomena occurring in solutions is not surprising in view of the fact that equality of vapour pressure is one of the most general conditions of equilibrium in physical chemistry. The relation of this assumption to the gas-pressure theory, or the hydrate theory, or the capillary pressure theory, as already indicated, is that it involves them all, since they may be regarded as merely different aspects of the same phenomena. An equivalent assumption may be formulated, at least approximately, in terms of partial pressure, or capillary pressure, or chemical attraction, but it would merely be putting the same thing in different words. The vapour-pressure method appears to be the most direct line of attacking the problem. If, for instance, we regard the changes of capillary pressure in relation to vapour pressure as defined by the relation $UdP=vdp$, we should arrive at nearly the same result by similar approximations. But this method does not appear to be so convenient, because it involves the volume U, which is generally unknown and variable in an uncertain manner, whereas the volume of the vapour $v$ at low pressures may be regarded as conforming very closely with the laws of gases.

There is no doubt that further experimental work may be required to establish the vapour-pressure theory generally, since accurate data for strong solutions are comparatively scarce. The interpretation of the ionisation factor, and its relation to the heat of dilution, requires further elucidation. Analysis of nearly all the data at present available, in addition to the examples above cited, fails to show any serious disagreement with the vapour-pressure theory. The theory cannot pretend to be exact for all ranges of temperature and concentration, but it seems likely to serve, at least as a second approximation, for coordinating results which have hitherto appeared discordant.

March 26.—"Comparison of the Board of Trade Ampere-standard Balance with the Ayrton-Jones Current Weigher; with an Appendix on the Electromotive Force of Standard Cells." By T. **Mather**, F.R.S., and F. E. **Smith**.

The paper describes experiments by which the relation between the Board of Trade ampere and one-tenth C.G.S. unit of current, as realised by the Ayrton-Jones instrument (Ayrton, Mather, and Smith, Phil. Trans., A, vol. ccvii., p. 463), was determined.

The comparison was carried out by aid of a combination of standard cells and resistances used as a secondary standard of current. This combination was evaluated by the Ayrton-Jones current weigher at the National Physical Laboratory on each of the three days during which experiments were made at the Board of Trade Laboratory, so that if any change occurred in the secondary standard it would be detected.

Two methods of comparison were employed, both giving concordant results, viz. one Ayrton-Jones ampere = $1{\cdot}0003_3$ Board of Trade ampere, the latter ampere being, therefore, smaller than the former by about 1/30 per cent.

A difference of this order was anticipated, for a recent determination of the electrochemical equivalent of silver (Smith, Mather, and Lowry, Phil. Trans., A, vol. ccvii., p. 579) by the Ayrton-Jones instrument gave 1·11827 milligrams per coulomb, whereas the Board of Trade balance was adjusted to correspond with 1·118 milligrams.

According to these experiments, the Board of Trade ampere will deposit silver at the rate of 1·1179 milligrams per second, so that *the Board of Trade ampere is equal to the international ampere, as defined by silver deposit, to within 1/100 per cent.*

The above experiments, combined with figures given by Prof. Ayrton and the authors (Phil. Trans., A, ccvii., p. 536), enable the E.M.F.'s of standard cells to be expressed in terms of the Board of Trade volt, this being defined as the P.D. between the terminals of a resistance of one Board of Trade ohm when one Board of Trade ampere is passing. The results are:—

E.M.F. of normal Weston cadmium cell = $1{\cdot}0186_8$ Board of Trade volts at 20° C.
E.M.F. of normal Clark cell = $1{\cdot}433_0$ Board of Trade volts at 15° C.

The Reichsanstalt value for the cadmium cell is 1·0186 at 20° C., and that for the Clark cell, determined directly by Mr. Trotter, 1·4329 at 15° C.

April 30.—"On Scandium." By Sir William **Crookes**, F.R.S.

Scandia is one of the rarest and least known of the recognised rare earths. It was discovered in 1879 by Nilson, who separated it, together with ytterbia, from erbia extracted from euxenite and gadolinite. Later in the same year Cleve extracted scandia from gadolinite, yttrotitanite, and keilhauite, and described the scandium sulphate, double sulphates, nitrate, oxalate, double oxalates, selenate, acetate, formate, oxide, and hydrate, and gave some of the chief reactions of the new body.

In the course of the author's twenty years' work on the fractionation of the rare earths, he has repeatedly tested his products by examining their photographed spectra, using the dominant lines of the various elements as tests for their presence. Scandium has an extremely characteristic group of lines in its spectrum, situated between wave-lengths 3535·864 and 3651·983, the strongest being at 3613·984, midway between two strong iron lines. By using a part of the spectrum in which this occupies the centre of the photograph, it is easy to see if scandium is present. Detecting the dominant line, the presence of scandium can be verified by reference to the other lines of the group.

The author found scandium in some of the fractions, but only in small quantities. A few years ago he commenced an examination of all the obtainable rare earth minerals in order to see if any of them showed more than a trace of scandium. The minerals examined were:—æschynite, allanite, alvite, auerlite, baddeleite (Ceylon), bastnasite, bröggerite, cerite, cleveite, columbite, cryptolite, eudialite, euxenite, fergusonite (Ceylon), fergusonite (Ytterby), fluocerite, gadolinite, hielmite, homolite, keilhauite, knopite, koppite, lanthanite, monazite, mosandrite, orangite, orthite, polycrase, pyrochlore, rhabdophane, samarskite, scheelite (Bohemia), scheelite (New Zealand), schorlomite, sipylite, tantalite, thalenite, thorianite, thorite, thorogummite, tscheffkinite, tysonite, urdite, wiikite, xenotime, yttergarnet, yttrialite, yttrocerite, yttrogummite, yttrotantalite, yttrotitanite, zirkelite (Ceylon, sp. gr. 5·0), zirkelite (Ceylon, sp. gr. 4·42).

Of the minerals examined, scandium was detected in auerlite, cerite, keilhauite, mosandrite, orangite, orthite, pyrochlore, thorianite, thorite, and wiikite.

Wiikite is a black amorphous mineral of specific gravity 4·85. Its hardness is 6. It is infusible before the blowpipe. It is imperfectly attacked by strong mineral acids, and breaks up easily when fused with potassium bisulphate. Heated to full redness in a silica tube, it gives off helium, water, and a distinct amount of sulphuretted hydrogen, followed by a white sublimate. The mineral begins to crack at a temperature a little below redness, and at the approach of redness gas is evolved with almost explosive violence, the mineral breaking up and flying about the tube. A fragment so treated examined under the microscope shows the surface covered with glistening points. With a high power these points are resolved into a mass of minute cubes, curiously regular in form and appearance. Heating drives off 5·83 per cent. of its weight; 5·82 of the loss is water and acid vapour, the difference, 0·01 per cent., consisting chiefly of helium, with a little hydrogen, carbon dioxide, and a mere trace of neon.

After the crude earths, chiefly yttria, ytterbia, and scandia, have been separated from the mineral, they are "fractionated" by methods described in the paper. Towards the end of the fractionation the chief impurity is ytterbium. Fortunately, the very strong dominant line of the ytterbium spectrum, wave-length 3694·344, occurs at a vacant part of the scandium spectrum, and near the characteristic group of scandium. A sample of scandia is not taken as satisfactory if the least trace of this line is seen on an over-exposed spectrum of scandium, and if the atomic weight is higher than 44·1. The atomic weight of ytterbium being 173, a very little of it as an impurity raises the atomic weight of scandium.

The author has prepared and analysed the following compounds of scandium:—scandium hydroxide, scandium carbonate, hydrated scandium chlorides, hydrated scandium bromides, scandium chlorate, scandium perchlorate, scandium bromate, scandium sulphates, anhydrous scandium sulphate, basic scandium sulphate, scandium and potassium double sulphate, scandium selenates, scandium nitrates, scandium formate, scandium acetate, scandium propionate, scandium butyrate, scandium iso-butyrate, scandium iso-valerate, scandium oxalates, scandium picrates, scandium pyromellitate, scandium camphorate.

**Royal Anthropological Institute**, May 5.—Prof. W. Ridgeway, president, in the chair.—Report on the Hythe crania: F. G. **Parsons**. An account was given of nearly 4000 measurements which the author made on 575 of the skulls under Hythe Church, Kent. The author reviewed the various historical facts in connection with them, as well as the numerous traditions and explanations which had from time to time been put forward to account for the presence of the crania. He declined to believe any of the numerous battle theories, and pointed out that skulls of women and children were plentiful, that earth was present in many of the crania, and that the injuries which have so often been referred to battle-axe and spear wounds were certainly inflicted many years after death, and were made probably by spades and pickaxes in digging up the skulls. From numerous details of collateral evidence the author argued that the bones probably must have come to their present place before the Reformation, and, as there were femurs of about 4000 people in the stack, must have represented the burials of more than a century. Mr. Parsons believed that the bones were of the thirteenth, fourteenth, and fifteenth centuries. The chief point of interest in the measurements was the shortness of the skulls, which averaged 17·9 cm. for the males. This is 1 cm. shorter than the two large London series lately recorded by Dr. Macdonnell, and goes far to disprove that observer's suggestion that the English head is gradually growing shorter and broader. The teeth were remarkable for their freedom from caries and for the wearing down of the crowns, pointing to hard, coarse fare. Many pathological specimens of bones were exhibited showing that osteo-arthritis and syphilis were very rife. The various abnormalities in the skull bones and sutures were classified, and their frequency recorded for future anatomical comparison.

**Chemical Society**, May 7.—Prof. E. Divers, F.R.S., in the chair.—The refraction and dispersion of triazo-compounds: J. C. **Philip**. A study of these constants shows that the contribution which the $N_3$-group normally makes to the molecular refraction is 8·91 units, and that to the molecular dispersion 0·36–0·37, but ethyl triazoformate, phenylazoimide, and α-naphthylazoimide show refractive and dispersive powers above the normal values. The bearing of these results on the formulation of the $N_3$-group is discussed.—The dissociation constants of triazoacetic and α-triazopropionic acids: J. C. **Philip**. The values found show that the introduction of the $N_3$-group into the molecule of acetic or propionic acid increases the strength of the acid nearly as much as the introduction of a bromine atom.—The fermentation of mannose and lævulose by yeast-juice (preliminary note): A. **Harden** and W. J. **Young**. Mannose is fermented by yeast-juice at almost the same rate as dextrose, whilst lævulose is fermented somewhat more rapidly. The peculiar influence of phosphates on the fermentation of these sugars by yeast-juice is described in detail.—The constituents of olive leaves: F. B. **Power** and F. **Tutin**. The following substances were isolated:—(1) a new monocarboxylic acid, $C_{22}H_{43}.CO_2H$; (2) a mixture of fatty acids containing oleic acid; (3) hentriacontane, $C_{31}H_{64}$; (4) pentatriacontane, $C_{35}H_{72}$; (5) oleasterol, $C_{20}H_{34}O$, a new crystalline alcohol related to the phytosterols; (6) a new crystalline alcohol, olestranol, $C_{25}H_{42}O_2$, which appears to be a hydroxyphytosterol; (7) homo-olestranol, $C_{27}H_{46}O_2$, a compound similar to olestranol; (8) *d*-mannitol; (9) a sugar which yields *d*-phenylglucosazone; (10) a trace of an essential oil; (11) oleanol, $C_{31}H_{48}O(OH)_2,N_2O$, which contains one alcoholic and one phenolic hydroxyl group.—The constituents of olive bark: F. B. **Power** and F. **Tutin**. The following crystalline compounds were obtained, together with some amorphous products:—(1) a new monocarboxylic acid, $C_{33}H_{67}.CO_2H$; (2) a new monocarboxylic acid, $C_{21}H_{43}.CO_2H$; (3) a new monocarboxylic acid,

$$C_{34}H_{69}.CO_2H;$$

(4) a new monocarboxylic acid, $C_{29}H_{57}.CO_2H$; (5) a substance, probably a tertiary alcohol, $C_{35}H_{68}O$; (6) pentatriacontane, $C_{35}H_{72}$; (7) a phytosterol, $C_{27}H_{46}O$; (8) a substance identical with ipuranol, recently isolated by Power and Rogerson from *Ipomoea purpurea*; (9) a new phenolic substance, olenitol, $C_{14}H_{16}O_6$; (10) *d*-mannitol; (11) a sugar which yields *d*-phenylglucosazone.—The reaction of diazonium salts with mono- and di-hydric phenols and with naphthols: K. J. P. **Orton** and R. W. **Everatt**. All diazonium salts couple quantitatively with

α- and β-naphthols in alcoholic media, but under similar conditions these salts do not combine with monohydric phenols. The dihydric phenols, resorcinol and orcinol, behave like the naphthols in alcoholic solution, but in aqueous solution only diazonium salts, with a preponderance of halogen atoms in the benzene nucleus, couple with the two dihydric phenols.—The condensation of benzoin with methyl alcohol: J. C. **Irvine** and D. **McNicoll.**—The mutual solubility of 2-methylpiperidine and water: O. **Flaschner** and B. **MacEwen.**—The melting points of the anilides, *p*-toluidides, and α-naphthalides of the normal fatty acids: P. W. **Robertson.** The irregularities in melting points in the series of anilides and *p*-toluidides seem to tend always in the reverse direction to those observed in the case of the amides. The disturbing factor appears to be a function of the lack of symmetry of the molecule, and is to a great extent eliminated on taking the mean melting points of the amides and anilides and of the amides and *p*-toluidides. In the fatty α-naphthalides, where the substituent group is heavier, irregularities tend to disappear.—The absorption spectrum of camphor: W. N. **Hartley.** The author confirms Baly, Marsden, and Stewart's statement that strong solutions of camphor in alcohol show a band in the spectrum due to the CO and $CH_2$ groups, but otherwise the substance is remarkably diactinic.—The viscosity of solutions: C. E. **Fawsitt.** A continuation of work on colloidal and alcoholic solutions.—The action of fused potassium hydroxide and of hydrogen peroxide on cholesterol (preliminary note): R. H. **Pickard** and J. **Yates.**—The volumetric estimation of silver: W. R. **Lang** and J. C. **Woodhouse.**—A criticism of Werner's theory, and the constitution of complex salts: J. A. N. **Friend.**—The action between potassium sulphite and potassium pentathionate: E. **Divers.** The author points out that the accuracy of Debus's investigation of the action between a sulphite and a pentathionate (Trans. Chem. Soc., liii., 278) is not affected by Colefax's quite recent work (*ibid.*, 1908, xciii., 798).—Note on phenolic thetines and their action with benzoyl chloride: E. de B. **Barnett** and S. **Smiles.**—The relation between dielectric constant and chemical constitution, part i., stereoisomeric compounds: A. W. **Stewart.** Examination of active and racemic compounds, and also of geometrical isomerides, shows that the influence of the spacial arrangement of atoms on the dielectric constants of isomeric substances is not clearly marked. In one case the active isomeride had a stronger absorptive power than the racemic form.—An apparatus for determining the specific inductive capacity of organic liquids: A. W. **Stewart.**—The influence of solvents on the rotation of optically active compounds, part xii., ethyl tartrate in aromatic halogen derivatives: T. S. **Patterson** and D. P. **McDonald.**—A new test for silver: A. W. **Gregory.** A solution of a silver salt to which has been added a mixture of aqueous ammonium salicylate with ammonium hydroxide furnishes on further addition of ammonium persulphate an intense brown colour. Lead does not give this reaction.—The spontaneous crystallisation of substances which form a continuous series of mixed crystals; mixtures of naphthalene and β-naphthol: H. A. **Miers** and F. **Isaac.**

**Linnean Society,** May 7.—Prof. W. A. Herdman, F.R.S., president, in the chair.—*Exhibits.*—Fruits of the "Buddha's Claw" variety of *Citrus medica* obtained at Easter from the gardens at La Mortola, formerly belonging to the late Sir Thomas Hanbury, also a normal fruit for comparison: Prof. F. E. **Weiss.**—Representation of the movements of Peripatus and other invertebrate animals by means of the Newman fire-proof kinematograph: F. Martin **Duncan.** The special feature of the apparatus used was that it enabled one to analyse all movement, picture by picture, instead of having to run the whole film through from end to end without a stop, as in ordinary kinematograph projectors. The effect of concentrated light upon different species of invertebrate animals had proved of interest and frequently a difficulty, so that colour filters and isochromatised negative film had in some cases to be used to obtain a satisfactory record.—*Papers.*—Colony-formation as a factor in organic evolution: H. M. **Bernard.**—Antipatharia from the voyage of H.M.S. *Sealark*: C. F. **Cooper.**—Fresh-water fishes, batrachians, and reptiles obtained by Mr. J. Stanley Gardiner's expedition to the Indian Ocean: G. A. **Boulenger.**—The madreporarian corals, part i., the family Fungidæ, with a revision of its genera and species and an account of their geographical distribution: J. S. **Gardiner.**

**Faraday Society,** May 12.—Mr. L. Gaster in the chair.—Apparatus for determining the boiling points of very small quantities of liquids: L. **O'Dowd** and Dr. F. Mollwo **Perkin.** This consists of a capillary tube which is placed in about 1/5 c.c. of the liquid the boiling point of which is to be determined. The liquid is contained in a small test-tube, which passes through a hole in the cork in such a way that the end containing the liquid comes in close contact with the thermometer also passed through the same cork. A stirrer is also provided. The heating liquid is contained in a flask capable of holding from 100 c.c. to 120 c.c., and may be either sulphuric acid, glycerin, or other suitable liquid. One end of the capillary tube is sealed, and the open end is so arranged as to be at the bottom of the liquid. On raising the temperature bubbles commence to give off from the end of the capillary tube, and when a constant stream of bubbles comes off the source of heat is removed. The thermometer is read at the moment the bubbles cease to be given off, that is, the temperature at which the temperature of the vapour in the capillary is equal to the atmospheric pressure and is the boiling point of the liquid. Numbers were given, showing for high boiling substances, and also for low boiling substances, that accurate results can be obtained.—Ozone, particularly in connection with water purification: Dr. F. Mollwo **Perkin.** After a historical introduction, the apparatus of Messrs. Siemens and Halske was described in detail. It consists of two concentric electrodes, the inside one of aluminium and the outside one of glass. The inner electrode is hollow, and is kept cool by a circulation of water. The outer one is also surrounded by water in order to prevent heating. The aluminium electrode is connected with one pole of the high-tension current (8000 volts). The containing vessel, which is filled with water, is of iron, and is earthed. This is thus the negative pole, and as water surrounds the glass pole it becomes electrified. Dried air is passed up an annular space between the two electrodes, and by means of the silent electric discharge becomes ozonised. From the ozoniser the air passes up towers filled with pebbles, over which water trickles. By this means a large surface of water is exposed to the action of the ozone; it thus becomes sterilised, and from here passes over cascades in order to remove any dissolved ozone. Messrs. Siemens and Halske have large installations dealing with the purification of water supply at Wiesbaden and at Paderborn. Other uses of ozone, such as the preparation of vanilla, the bleaching of flour, and other purposes of oxidation, were also mentioned. An apparatus for laboratory use was exhibited in working.—Dr. **Veley** showed an apparatus for the determination of dielectric constants of non-conducting liquids.

**Royal Meteorological Society,** May 20.—Dr. H. R. Mill, president, in the chair.—Upper air observations in Egypt: B. F. E. **Keeling.** The whole prosperity of Egypt is connected with the weather of the neighbouring country of Abyssinia. As the summer rainfall is greater or less in Abyssinia, so is the Nile flood, and in consequence the area of land cultivated and the general prosperity is greater or less. In years when a bad, low stage of the river is to be expected, following on a bad flood, the early spring showers in Abyssinia are then of very great importance. As, unfortunately, there is no meteorological service in Abyssinia, it is not possible to obtain information about the rainfall over that region, so steps have recently been taken to obtain observations on the upper air over Egypt by means of pilot balloons and kites. Mr. Keeling gave an account of the methods employed, and of the directions in which it was hoped in the near future to develop the work. He also stated that the observations of the anti-trade winds made by M. Teisserenc de Bort and Mr. A. L. Rotch have been confirmed. At Helwan the anti-trade wind is reached at a height of about 6500 feet above sea-level. The greatest height so far reached by a balloon was 54,000 feet, and on that occasion the south-west anti-trade wind was apparently penetrated and a north-west upper current encountered.—Balloon experiments in Barbados, November 6–8, 1907: Prof. J. P. **d'Albuquerque.**—Observations on the colour of lightning made at Epsom, 1903–7: S. C. **Russell.** The author had for the past five years kept a record of the colours or series of colours noted during each thunderstorm or display of sheet lightning, and tabulated them under their respective colour. He had thus results of observations of fork lightning made during fifty-seven thunderstorms, and seventy-eight observations of sheet lightning. It appears that in fork lightning red is the colour of the most frequent occurrence, and this is followed closely by blue, the least frequent colours being orange and green. White is of the greatest frequence in sheet lightning, red and yellow being next. It seems that the presence of hail, when occurring in association with a thunderstorm, is intimately connected with blue lightning.

**Institution of Mining and Metallurgy**, May 21.—Mr. Alfred James, president, in the chair.—The electrical equipment of gold mines: H. J. S. **Heather.** Continued discussion on this paper.—The behaviour of tellurium in assaying: Sydney W. **Smith.** An examination of the behaviour of this substance during pot-fusion, scorification, and cupellation in order that some reasons may be offered for taking the precautions which are generally regarded as necessary to ensure successful work. The paper describes a number of careful observations made with this end in view, and a summary of the conclusions arrived at is given.—The average rate of accumulation and absorption of gold amalgam by copper plates: Edward **Halse.** The absorption and accumulation of gold on copper plates: W. F. A. **Thomae.** These two papers deal with the same subject, the general conclusion of the two authors being that the absorption of gold by copper plates may be ignored by the mill-man in view of its small importance. In no case does the average rate appear to exceed a fraction of a grain per ton milled, and in the case of ore containing coarse gold it is practically nil. The authors look at this matter from somewhat different points of view, Mr. Thomae especially thinking that further data might be worth placing on record.—A journey to Central Asia: A. **Adiassewich.** This paper records the results of travels in Central Asia, with special reference to the position and prospects of the mining industry there. After a general description of the conditions of mining, the author passes in review the leading districts, Orenburg, the Khirgiz Steppes, &c., and gives details of the occurrence of gold, silver, copper, iron and other ores, coal, and petroleum.

PARIS.

**Academy of Sciences**, May 18.—M. H. Becquerel in the chair.—The hovering flight of birds: Marcel **Deprez.**—The turning of aëroplanes: Paul **Renard.** To turn an aëroplane requires that the apparatus should incline transversely a given amount; it will, in addition, usually have the effect of lowering the trajectory. Before making a turn it will therefore be necessary to rise if the original height is to be maintained at the end of the turn.—The profile of the polar masses of dynamos: Paul **Girault.**—The ultramicroscopic examination of charged centres in suspension in gases: M. **de Broglie.**—The re-combination of the ions in dielectrics: P. **Langevin.** On the supposition that in gases the re-combination of the ions with contrary signs is due to the attraction of their electric charges, the author has shown in an earlier paper that relation $\frac{\alpha}{4\pi(k_1 + k_2)} \leq 1 = \epsilon$ holds, in which $\alpha$ is the coefficient of re-combination, $k_1$ and $k_2$ the mobilities of the positive and negative ions. In the present paper the application of this formula to the case of solid dielectrics is considered, and a simple method described of determining $\epsilon$.—The influence of the surrounding atmosphere on the friction between solid bodies: F. **Charron.** The presence of moisture, benzene vapour, or alcohol vapour in the air reduces the friction, but no variation could be observed when the air round the moving parts was replaced by dry hydrogen, carbon dioxide, or ethylene.—The auto-excitation of a tri-phase alternator by means of electric valves: C. **Limb.**—The differences of contact potential between metals and liquids: L. **Bloch.** The apparent difference of contact potential between metal and liquid is smaller for alkaline solutions than for water, and smaller for water than for acid solutions. Salts give effects differing only slightly from water. The method is sensitive enough to detect traces of acid and alkali beyond the reach of detection by colour reagents.—The radiography of the lungs and stomach of the fœtus and still-born infants: M. **Bouchacourt.** In infants whose lungs have been filled with air, the lungs show definitely in the radiograph, but the usual practice of artificial inspiration in the case of infants apparently still-born may lead to the erroneous conclusion that the child has lived. The causes of the visibility of the stomach in the radiograph are also discussed.—Observation on the time required for the solution of substances: Gaston **Gaillard.** The substances studied were sodium thiosulphate, sugar, and sodium sulphate. The effect of the size of the crystal and rate of agitation have a great influence on the results, and it is only when these two factors are kept as constant as possible that comparative measurements can be obtained.—A photographic action of infra-red light: A. Gargam **de Moncetz.** The gelatinobromide plates were fogged by the X-rays previous to the exposure to the red rays, the light being filtered through a solution of iodine in carbon bisulphide capable of cutting off all rays between 800 λ and 4 λ. The plate showed clear effects of the exposure for wave-lengths between 920 λ and 1350 λ. The preliminary fogging of the plates by ordinary light instead of by the X-rays did not give these results.—The kinematographic study of the Brownian movements: Victor **Henri.** The path described by a particle, as shown by these experiments, was very complex; it varies from one particle to another, and is absolutely independent for each particle even when two particles only $2\mu$ apart are compared. The trajectory often shows abrupt changes of direction. The displacements measured for 0·05 second were compared with those deduced by Einstein's formula, and were found to be about four times greater than the latter.—The iodomercurates of thorium and aluminium: A. **Duboin.** The preparation and properties of $ThI_4,5HgI_2,18H_2O$ and $AlI_3,HgI_2,8H_2O$ are described.—The definite compounds of silicon and palladium: Paul **Lebeau** and Pierre **Jolibois.** Silicon and palladium unite directly with evolution of heat, giving rise to two definite silicates, $Pd_2Si$ and PdSi, the first of which has been separated and analysed. The existence of the other silicide has been deduced from the determination of the fusibility curve and the metallographic study of the ingots obtained. These silicides are analogous to the platinum silicides already known.—A method for the volumetric estimation of tartaric acid in argol and cream of tartar: Em. **Pozzi-Escot.** The method is based on the insolubility of barium tartrate in alcohol, and the solubility of barium bromide in the same solvent. The excess of barium used is converted into the oxalate, and the latter determined with potassium permanganate.—The elimination of carbon monoxide from coal gas: Léo **Vignon.** Details of laboratory experiments on three methods are given: the conversion into methane by reduced nickel, the transformation into carbon dioxide by heating with oxide of iron at definite temperatures, and the direct absorption with cuprous chloride. The question of the cost of treatment or the value of the gas after such treatment is not dealt with by the author.—Propargylcarbinol: MM. **Lespieau** and **Pariselle.** Starting with the ester $CH_2Br—CHBr—CH_2—CH_2.OCH_3$, this is successively converted into 1:2:4-tribromobutane by the action of hydrobromic acid, 2:4-dibromobutene, from the preceding by the action of potash, the alcohol, $CH_2{=}CBr—CH_2.CH_2OH$, and the sought for acetylenic alcohol,

$$CH \equiv C—CH_2.CH_2OH.$$

—The mixed trihalogen derivatives of methane: V. **Auger.** A description of the preparation and properties of $CHCl_2I$, $CHClI_2$, $CHBr_2I$, and $CHBrI_2$.—The constitution of the combinations of tetramethyl-diamino-benzhydrol with some methylenic derivatives: R. **Fosse.**—Some orthobenzylated colouring matters from triphenylmethane:

A. **Guyot** and P. **Pignet.**—The cytology of the renal labyrinth of the Thysanoura: L. **Bruntz.**—The biology of a parasitic Rhabdocœle of *Cardium edule*: Paul **Hallez.**—The action of the X-rays on the evolution of the mammary gland during pregnancy in the rabbit: MM. **Cluzet** and **Bassal.** The evolution of the mammary gland may be hindered at all stages by the application of the X-rays, the maximum effect being produced when it is made in the course of the first fortnight.—The arrest and prolonged detention of radium sulphate in the living tissues: H. **Dominici** and **Faure-Beaulieu.**—The theory of electrical stimulation: Louis **Lapicque.**—An attempt to separate hypertensive substances from the urine: J. E. **Abelous** and E. **Bardier.**—Epithelioma and the parasitic nature of cancer: F. J. **Bosc.**—Acute tuberculous septicæmia of the guinea-pig: André **Jousset.**—Tubercles and fossil stems of Equisetum: P. H. **Fritel** and René **Viguer.**—The utilisation of faults for the determination of the mean density of the earth: A. **Berget.**—The study of the sea floor in the bay of the Seine: J. **Thoulet.**

GÖTTINGEN.

**Royal Society of Sciences.**—The *Nachrichten* (physico-mathematical section), part i. for 1908, contains the following memoirs contributed to the society:—

December 21, 1907.—The Pyrenomycetes and Tuberaceæ of the Göttingen flora: A. **Peter.**—The fundamental equations for the electromagnetic processes in moving bodies: H. **Minkowski.**

February 8, 1908.—Researches from the Göttingen University chemical laboratory (xix.) (1) Dissociation by the addition of water in terpene compounds; (2) synthesis of α-phellandrene; (3) synthesis of isofenchone ($C_{10}H_{16}O$) from nopinone ($C_9H_{14}O$): O. **Wallach.**—The differential equations of binary semi-invariants and invariants in independent substitutions: W. Fr. **Meyer.**

February 22.—The uniformisation of algebraic curves (imaginary substitution-groups): P. **Koebe.**

## DIARY OF SOCIETIES.

*THURSDAY*, MAY 28.

ROYAL SOCIETY, at 4.30.—On the Theory of Capillarity: Prof. E. T. Whittaker, F.R.S.—Effect of a Cross Wind on Rifled Projectiles: A. Mallock, F.R.S.—Transparent Silver and other Metallic Films: Prof. T. Turner.—Mrs. Ayrton will give Demonstrations of Wave-Motion in Water. (Paper read January 30, 1908.)

ROYAL INSTITUTION, at 3.—The Chemistry of Photography: Dr. Alexander Scott, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

*FRIDAY*, MAY 29.

ROYAL INSTITUTION, at 9.—Ancient and Mediæval Projectile Weapons other than Firearms: Sir Ralph Payne-Gallwey, Bart.

*MONDAY*, JUNE 1.

ARISTOTELIAN SOCIETY, at 8.—Person and Thing: Prof. G. Dawes Hicks.

INSTITUTE OF ACTUARIES, at 5.—Annual General Meeting.

*TUESDAY*, JUNE 2.

ROYAL INSTITUTION, at 3.—Animal Heat and Allied Phenomena: Prof. William Stirling.

*WEDNESDAY*, JUNE 3.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Studies in Steam Distillation. Part iii., The Fatty Acids: H. Droop Richmond.—The Detection of Poisonous Metals: Dr. G. D. Lander and Mr. H. W. Winter.—The Estimation of Coconut Oil in Butter: Raymond Ross.—Ochoco Fat: Dr. Julius Lewkowitsch.—The Detection of Small Quantities of Methyl Alcohol in the Presence of Ethyl Alchohol: I. E. Hinkel.—The Separation of Certain Volatile Fatty Acids by Extraction with Benzene or Toluene: T. R. Hodgson.

ENTOMOLOGICAL SOCIETY, at 8.—On certain Nycteribiidæ, with Descriptions of Two New Species from Formosa: Hugh Scott.—Descriptions of some new Hesperidæ from Central and South America: Hamilton H. Druce.—Mimicry in Tropical American Butterflies: J. C. Moulton.—Heredity in the South-east African Form (*cenea*) of *Papilio dardanus* (*merope*): G. F. Leigh.

GEOLOGICAL SOCIETY, at 8.—On the Fossiliferous Rocks of the Southern Half of the Tortworth Inlier: F. R. C. Reed and Prof. S. H. Reynolds.

*THURSDAY*, JUNE 4.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On the Aberration of Sloped Lenses and on their Adaptation to Telescopes of Unequal Magnifying Power in Perpendicular Directions: Lord Rayleigh, O.M., Pres. R.S.—On the Viscosity of Ice: R. M. Deeley.—The Effect of Temperature on the Neutralisation-Volume Change for Different Salts at Different Concentrations: Miss Ida Freund.—Note on a New Sounding Machine for Use on Lakes and Rivers without a Boat: Prof. E. J. Garwood.

ROYAL INSTITUTION, at 3.—The Chemistry of Photography: Dr. Alexander Scott, F.R.S.

LINNEAN SOCIETY, at 8.—Note on the Spicules of *Chirodota gemmifera* Dendy Hindle: Prof. A. Dendy, F.R.S.—Two New Fungus Diseases: E. S. Salmon.—The Caryophyllaceæ of Tibet: F. N. Williams.—Polychæta of the Indian Ocean: F. A. Potts.—The Stylasteria of the Indian Ocean: Dr. S. J. Hickson, F.R.S., and Miss Helen M. England.—A Contribution to the Mycology of South Africa: W. N. Cheesman and T. Gibbs.—*Exhibits*: Drawings prepared to illustrate Descourtly's "Ornithologie brésilienne.": C. E. Salmon.—Lantern-slides of the Life-history of a Wood-boring Wasp: F. Enoch.

INSTITUTION OF MINING ENGINEERS, at 11 a.m.—Presidential Address by C. E. Rhodes.—The Mineral Resources of Trinidad: J. Cadman.—The Occurrence of Fluorspar in Derbyshire: C. B. Wedd and G. C. Drabble.—Calcining-kilns: G. Jones.—Cobalt and Northern Ontario: J. B. Tyrrell.

CHEMICAL SOCIETY, at 8.30.—Condensation Products from Pinene Aminodicarboxylic Acid: W. Godden.—A Delicate Test for Bromides alone, or in Solution with Chlorides: J. S. Jamieson.—Experiments on the Synthesis of 1-Methylcyclohexylidene-4-acetic Acid: W. H. Perkin and W. J. Pope.—The Triazo-group. Part iv., Allyl Azoimide: M. O. Forster and H. E. Fierz.

*FRIDAY*, JUNE 5.

ROYAL INSTITUTION, at 9.—The Nadir of Temperature and Allied Problems: Sir James Dewar, F.R.S.

INSTITUTION OF MINING ENGINEERS, at 11 a.m.—Winding-engine Tests, with Notes and Suggestions on the Design and Testing of Plant: S. L. Thacker.—The Utilisation of Sewage for the Production of Crude Oil and Ammonia: M. F. Purcell.—The Oil Prospects of Central British South Africa: Dr. C. Sandberg.—Oil-mining: D. M. Chambers.—Mining in the Boundary District of British Columbia: F. Keffer.

## CONTENTS.

THURSDAY, JUNE 4, 1908.

## SCIENCE IN FOLKLORE.

*Folklore as a Historical Science.* By G. L. Gomme. Pp. xvi+371. (London: Methuen and Co., n.d.) Price 7s. 6d. net.

AS its title leads us to suppose, this interesting volume is a plea for the recognition of folklore as a historical science. Seeing that the barrier between history and folklore is still unbroken, in spite of the efforts of Miss Harrison, Dr. Frazer, and others, the author has resolved to destroy it once for all, and has endeavoured to convince us that historical fact is often the essence of tradition, and that we must look to folklore for most if not all our light on the early stages of the psychological, social, and political development of modern man. In support of his argument, and by way of illustration, he has drawn on his vast store of instances, and discussed legends attached to places and historical persons, folk-tales such as Catskin, Faithful John, &c., which imply savage social conditions, and tribal laws and rules, rhythmical if not in verse, which have been handed down by word of mouth and preserved in historical times. Yet, in spite of the proofs at his command, he fears that the historians may refuse to admit the value of folklore as evidence, and believing that a change in their attitude must be preceded by a change in the attitude of the folklorists themselves, he urges on the latter a more rigid scrutiny of their data, and a more judicious use of the comparative method, than has been customary hitherto. Not only must they ascertain the position of each item of folklore in the culture area in which it is found, but must try to determine its correct relation to other items in that area, taking heed to compare like quantities alone. Only thus can they hope to discover the underlying facts, and to offer the historians materials they can use.

After indicating the relation of folklore to history, and the system to be followed by the folklorists, he discusses in the last half of the volume the aspects under which they must regard it, and the conditions they must take into account if their labour is to end in a real increase of knowledge.

The explanation of the folklore of a people should be sought, as Mr. Gomme thinks, in its anthropological history, especially in the stage of its development known as totemism, and as this is a topic on which opinion is divided he discusses it at considerable length. From totemistic survivals he passes on to speak of those which can be subjected to sociological and ethnological tests, and shows that certain differences in folklore are to be accounted for as the results of different race origins or a different social organisation. In discussing European folklore he emphasises the need of bearing in mind the introduction of a foreign religion, viz. Christianity, and the manner in which it affected and was affected by the existing beliefs.

For want of space we are unable to criticise the work in detail, and must content ourselves with a few general observations. Most of its readers will allow that folklore should be treated as a science, and that the principles of its study have been correctly laid down by the author. They will commend him, too, for rejecting the methods of the destructive school and laying stress on the value of popular beliefs. The scepticism of Voltaire and his followers was a natural reaction from mediæval credulity, and was bound to precede any real advance in historical writing. Our scholars of to-day are differently placed; as research has become closer and more extensive, their respect for tradition has been increased in many cases rather than diminished; they are no longer content to doubt; they must separate the truth from the overlying falsehood. In the light of our fuller knowledge, Voltaire's treatment of the myth of Romulus and Remus, for example, seems partial and unscientific; Mr. Gomme, in discussing, for instance, the story of the Frog Prince or the descriptions of Britain by classical writers, greatly surpasses him in breadth and acumen. To our mind, however, his conservative tendency is nowhere more happily expressed than in his refusal to dismiss as superstition the attempts of our savage ancestors to account for natural phenomena. He shows with admirable insight that their mental process was the same as that of their cultured descendants—"primitive myth is primitive science"—and the mistakes they made were but the natural outcome of severely accurate reasoning from insufficient data.

Yet, sensible as we are of his largeness of view and the excellence of his methods, we are not altogether satisfied as to the truth of his main contention; we are far from certain that "the gap in the heart of things" is not too wide to be bridged over by folklore. His analysis of the various folk-tales is masterly and suggestive, but he leaves us unconvinced that his results are worthy of his pains, that the data of folklore are matter for the historian, and not, as hitherto supposed, for the philosopher. It is only just to say that these doubts may not be felt by all, not to mention that they may be lessened or removed by his promised volume on "Folklore in Early British History." Be that as it may, we are less inclined to quarrel with him for mistaking the uses of folklore than for his attitude on certain other points, than, to take one instance, for his somewhat cavalier treatment of the mythologists. It is one thing to say that the key to folklore is anthropology; it is another to suggest that there are no traces of national gods among the European peoples, and that the objects of adoration were always of the tribe. Even if the European sky-god is a fabrication of "the Cambridge professor," even if Lud on the Thames and Nod on the Severn were distinct until the Romans united them, he is hardly justified in such sweeping generalisations; he has still to account for, *e.g.*, the cult of Lug in regions so far apart as Leyden and Lyons and County Wicklow, as well as at a host of intermediate places. It is possible that we shall receive greater satisfaction from the new volume; so far it cannot be allowed that the author has said the last word on the subject.

The book requires no praise from us. It is enough to say that it sustains Mr. Gomme's high reputation as a folklorist, and that those who devote time to its study will be amply rewarded. It possesses an additional source of interest in its well-chosen illustrations. "The Two Scenes from the Life of St. Guthlac" bring before us with peculiar vividness the unseen world as it presented itself to some of our forefathers.

## A ZOOLOGIST AS ÆSTHETE.

*Ästhetik der Tierwelt.* By Karl Möbius. Pp. v+128; 3 plates and 195 figs. (Jena: G. Fischer, 1908.) Price 6 marks.

AS director of the great zoological museum in Berlin, the late Prof. Möbius was naturally led to consider the æsthetic value of the various forms of animal life as well as their scientific interest. From time to time he published brief essays discussing different types of animals from the æsthetic point of view, and as he found the inquiry very profitable—increasing his delight in the animal creation—he gathered his reflections together in the beautifully illustrated book before us, which bears the pleasant title "Ästhetik der Tierwelt."

Certain animals cannot be seen without being greatly admired, others are regarded with complacency but without enthusiasm, others with entire indifference, and yet others with repugnance—which is often affectation. Prof. Möbius sought to discover some of the reasons for this diverse æsthetic value that animals seem to have, and his *à priori* method led him to judgments which it would be of great interest to test statistically, by collecting opinions from, say, 5000 of each of the following groups:—country children, men in the street, well-dressed women, naturalists, and artists. It is notoriously difficult, however, to get a frank expression of æsthetic emotion (especially in regard to animals), to allow for conventional prejudice and posing, for sheer uneducatedness of vision, and for entirely artificial associations which lead many people to recoil from forms of life which the artist admires. We find in this book many statements like this:—"Die Fledermäuse findet niemand schön," and the author tried to show that this universal disapprobation is justified according to certain canons of æsthetic criticism. So much the worse for these canons, it seems to us, not that we can believe in the universal disapprobation of bats.

Prof. Möbius pointed out that our æsthetic judgments as to animals rest on a complex objective and subjective basis; he went on to discuss the general qualities of a beautiful living creature—it must be a unity, it must be harmonious, it must have individuality, and so on. We regret that the illustrious author did not expand his reflections on these matters, instead of giving so much space to comparing the relative merits of crab and lobster, or analysing the alleged "Hässlichkeit" of hippopotamus and giraffe. It seems to us that just as we are pleased by a piece of carving, rude though it may be, which expresses the craftsman's mood, and shows him to be even a little bit of a creator, so, but infinitely more, are we pleased by the individuality of organisms—every one its own artist—no one of which uses its materials quite in the same way. An interesting short chapter is devoted to the æsthetic value of animals as parts of a landscape; thus what is not impressive in isolation gets its value in its natural setting. This is well illustrated by reference to the associations seen on a coral beach at low tide.

The volume attempts an analysis of beauty in animal architecture, but the treatment seems to us too dogmatic and aprioristic. We demand symmetry, it is said, yet what delights us more than a lop-sided shell from the shore? A Campanularian is not so beautiful as a Corallium, because the number of its tentacles is a distracting conundrum. A centipede makes us tired, it is said, with its monotony, "Man sieht nichts Neues, wird ermüdet und gelangweilt," whereas to many people a centipede quickly moving among the bark is in its way just as beautiful as a peacock. Spiders are not so much appreciated as butterflies, because their body has only two main parts, and the æsthetic unity is spoilt by the distractions of the abdomen when we are contemplating the cephalothorax, and *vice versâ*. It is unconventional for an animal to be broader than it is long, and, therefore, to use one of the author's examples, Geryon must take a back seat when Gammarus appears. But when it comes to ranking Peripatus among the animals with "langweilende Wiederholung," and putting Nymphon among the unsatisfactory because it lacks sufficient central mass to rivet the eye, we cannot but disagree. We may take shelter behind the eirenic maxim, "De gustibus non disputandum est," but we are not afraid of the responsibility of stating a counter-thesis, with which we think most artists will agree, that no natural animals are ugly or "hässlich" in the sense of being out of proportion or out of harmony, or "bad colour." It seems to us that the only ugly animals are such as prize pigs, on which man has laid violent hands. One of the delights of animal coloration is the daring as well as the subtlety of the experiments, but is any result ever a failure in the sense that a picture or a picture-hat may be?

J. A. T.

## FUNDAMENTAL PRINCIPLES OF CHEMISTRY.

*Stoichiometry.* By Prof. Sydney Young, F.R.S.; with an Introduction to the Study of Physical Chemistry by Sir William Ramsay, K.C.B., F.R.S. Pp. lxxi+381. (London: Longmans, Green and Co., 1908.) Price 7*s.* 6*d.* net.

THIS volume, as its unfamiliar title implies, is concerned with the fundamental principles of chemistry, and so forms logically the first of the "Text-Books of Physical Chemistry" edited by Sir William Ramsay; the introduction, which has appeared before, is appropriately reprinted in this volume. We are pleased to see that five more volumes of the series are in preparation.

Recent research on atomic and molecular weights, of which Prof. Young gives a clear and simple account, has proceeded mainly in two directions. D.

Berthelot, Lord Rayleigh, Leduc, Guye and his co-workers, from the study of gases have been able by a nice combination of exact theory and experiment to bring independent evidence as to the molecular weight of gases; at the same time, Morley, T. W. Richards, and others at Harvard have considerably increased the accuracy with which the more important atomic, or rather combining, weights are known. Prof. Young's own researches have been closely related to the former investigations.

The problem in the deduction of accurate atomic and molecular weights from the properties of gases is the precise application of Avogadro's hypothesis; that is, it is necessary to know the relative volumes (at 0° and one atmosphere) of the gas under consideration and oxygen, which contain equal numbers of molecules. When these volumes are known, the weight of the molecule of the gas can be found at once from its density relative to that of oxygen. Berthelot assumes that Avogadro's hypothesis is strictly true when gases are at small pressures; to apply this assumption, $pv$ has been observed at a small pressure and at one atmosphere for several gases, including oxygen. Guye uses the principle of corresponding states; for example, argon and oxygen have approximately the same critical pressure and temperature, so he assumes that equal volumes of these two gases (at 0° and one atmosphere) have the same number of molecules; and finally, the values of $a$ and $b$ in van der Waals's equation have been used directly to find the Avogadro volumes. The atomic weight of nitrogen obtained in this way is 14·01, as opposed to the formerly accepted 14·04; there is plenty of evidence that the smaller value is the more accurate one.

As was to be expected, the treatment of change of state, van der Waals's theory, the vaporisation of mixed liquids, &c. (where so much of the best work is that of Prof. Young himself), is at once clear, precise, and interesting.

The first chapter, of twelve pages, on "The Fundamental Laws of Chemical Combination," which also includes Dalton's atomic theory, seems to us entirely unsatisfactory, and falls much below the standard of the rest of the book. These fundamental subjects receive the usual inadequate treatment which mars so many elementary text-books of chemistry. The definition of an element, as a substance not decomposable *at will*, is artificial, and merely avoids the difficulties raised by the well-verified spontaneous change of radium into helium. Our complaint, however, is with the presentment of the laws of chemical combination. When a generalisation is raised to the dignity of being called a law, surely the value of science as a method of thought demands, (1) the definition of the law in clear and precise language, (2) a statement of the observations (with their accuracy) upon which the law is based? None of these is done for the law of definite proportions. It is high time the "law" of multiple proportions was omitted from text-books. The statement of it criticised ends with the words "vary in the different compounds according to very simple numerical proportions." Consider $C_{60}H_{122}$ and $C_8H_{14}$ (*i.e.* $C_{60}H_{105}$); can the ratio 122 : 105 be called "very simple numerically"? Few pairs of compounds obey the "law." Though Dalton's atomic theory was only accepted by chemists generally after half a century of controversy, and is at present rejected by a few, in the two pages devoted to it in "Stoichiometry" the difficulties of the theory are not even mentioned. It is to be hoped that these blemishes may be removed in a future edition from a book which gives such an up-to-date and adequate account of a large part of physical chemistry, and is one of the volumes most needed of a valuable series.

T. H. L.

## NEWTON'S PHILOSOPHY.

*La Philosophie de Newton.* By Dr. Léon Bloch. Pp. 642. (Paris: F. Alcan, 1908.) Price 10 francs.

THE subject of this book is Newton's "philosophy" in the large sense in which Newton himself understood that word, not in the narrower sense which is now usual. The author passes in review practically the whole of Newton's contributions to science, giving in each case their antecedents, their method, and their outcome. His historical accounts of previous discoveries, with the consequent estimates of Newton's contribution, are usually excellent, and in his exposition of Newton's ideas he is in general very faithful to his original.

M. Bloch's successive chapters, dealing with different parts of Newton's work, have a certain similarity of structure. They generally begin with Descartes, and show the element of arbitrary hypothesis in his views. Then, after some account of intermediate writers, they point out how Newton proceeded by the right inductive methods, collecting his laws and definitions from facts, and verifying their consequences by experiments. The hypotheses which he objected to, it is said, were not hypotheses used as such, but hypotheses used as though they were known to be true. It was still customary to object to a new theory, based on observation and experiment, not that it failed to explain the facts, but that it contradicted the maxims of the illustrious So-and-So. This attitude seems strange to us, because it has so completely died out in science. But it still survives in philosophy, where emphatic assertion is one of the accepted methods of proof; and from this analogy we can understand Newton's attitude and the progress it involved. M. Bloch's scheme involves some unnecessary repetitions, and one gets a little tired of the merits of induction. But substantially what he says on this subject seems just. While attributing to Bacon a great influence in forming Newton's ideas of method, he explains the two respects in which Newton surpassed Bacon's precepts, namely, that his methods were quantitative, and that he realised the part which deduction plays in induction.

Where the book is least satisfactory is on the side of logical analysis. Thus in regard to fluxions, he points out, very justly, how Newton conceived a fluxion physically, and how he often inferred the existence of limits, in problems where his mathematical apparatus was insufficient to prove it, from the fact that he was dealing with physical problems which must have definite solutions. But M. Bloch does not adequately discuss the postulates involved, or consider how, from a modern point of view, one could justify practically a procedure such as Newton's. He seems more or less unaware of the gulf which nowadays separates the pure mathematician's account of the calculus from the physicist's use of it, and therefore cannot deal thoroughly with the very interesting question as to how this gulf is to be bridged. To take another illustration; he gives an account of Newton's views on absolute space, time, and motion, and quotes the experiment of the rotating bucket of water, by which absolute rotations are to be discovered. But instead of endeavouring, after the example of many previous writers, to refute in detail the inferences drawn by Newton from this experiment, he contents himself with pointing out the dynamical irrelevance of absolute *translation*, and extending this by means of generalities to absolute *rotation*. The truth seems to be that he, in common with many moderns, is here indulging in an hypothesis of just that kind which Newton endeavoured to avoid: absolute rotation is impossible *a priori*; therefore, if the facts require it, so much the worse for the facts.

There are an unusual number of misprints, and some of them seem to be among the references. In spite of blemishes, however, the book is careful and erudite, and on the historical side very useful.

## OUR BOOK SHELF.

*The Common Bacterial Infections of the Digestive Tract and the Intoxications arising from Them.* By Prof. C. A. Herter. Pp. xii+360. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1907.) Price 6*s*. 6*d*. net.

THIS book forms a valuable summary of our knowledge of many of the bacterial infections of the digestive tract, and of the conditions resulting therefrom—valuable alike to the bacteriologist, the chemist, and the clinician. It commences with a review of the normal bacterial flora of the digestive tract, and the significance of the presence of bacteria is first discussed. It is shown that the intestinal bacteria are not required to carry on the ordinary digestive processes and normal nutrition, and the conclusion is formulated that the chief significance of the obligatory intestinal bacteria lies in their potential capacity for checking the development of other types of organisms capable of doing injury.

An interesting section deals with the differences in the bacterial flora of the intestine in nurslings and in bottle-fed infants; the number of bacteria is found to be considerably greater in the latter, and a majority of the organisms present are Gram-negative instead of Gram-positive, as is the case in nurslings. Another feature of interest which is well brought out is that in old age a greater number of putrefactive becteria are present than in youth. The origin and precise significance of this difference is not yet clear, but it suggests that intestinal infections stand in a causative relation to old age, an hypothesis recently advanced by Metchnikoff, and the author confidently states that the onset of senility may be distinctly accelerated through the development of intestinal infections in which putrefactive anaërobes are prominently represented. A number of details are given for the analysis of the intestinal contents, and of the significance of the data derived therefrom, together with hints as to treatment. R. T. HEWLETT.

*National Antarctic Expedition*, 1901-4. "The Charts of the *Discovery* Antarctic Expedition." By Lieut. G. F. A. Mulock. (London: Royal Geographical Society, 1908.)

THE charts illustrating the work of the National Antarctic Expedition, compiled by Lieut. G. F. A. Mulock, R.N., surveyor and cartographer to the expedition, have now been issued by the Geographical Society in the form of one of its supplementary publications. The series consists of a general chart of the Ross Sea and its coasts, and five on a larger scale showing the detailed geographical work of the expedition. The maps are clearly printed in three colours, the ice-coloured regions being shown in blue, the bare rocks in brown, and routes and altitudes in red; they are folded, and issued in a convenient cloth case, 10 inches high by 6¾ inches wide. They are accompanied by a short statement of eight pages recording the methods of survey and chief determinations, in which Lieut. Mulock gives credit to his colleagues for their contributions to the work, referring especially to Ferrar's survey of the Ferrar glacier, Bernacchi's determination of the longitude of the winter quarters, Dr. Wilson's sketches of the coast, and Lieut. Skelton's photographs.

The three charts of most interest are those including the Great Ice Barrier and the route of Captain Scott's remarkable sledge journey on to the plateau of southern Victoria Land. Lieut. Mulock retains the name the Great Ice Barrier, and adopts it for the whole ice sheet of which Ross discovered the northern face. Notes on the chart direct attention to the convincing evidence that the edge of this ice sheet is floating, and also of its recession at one place for twenty-three miles since it was discovered by Ross. Confidence in the latter fact is strengthened by Lieut. Mulock's testimony to the remarkable accuracy of Ross's positions. On a second chart the author shows the extension of Ross's Great Ice Barrier to the south, with the route of Scott and his two companions to their farthest south at the entrance to Shackleton Inlet, and of the face of the mountains on the western coast of that part of Antarctica.

Lieut. Mulock is to be congratulated on the skill and care with which he has incorporated all the observations of the expedition into this important series of charts, which are a most valuable addition to Antarctic cartography. J. W. G.

*Archhelenis und Archinotis. Gesammelte Beiträge zur Geschichte der neotropischen Region.* By Herman von Ihering. Pp. iv+350. (Leipzig: W. Engelmann, 1907.) Price 6 marks.

FEW and far between are the naturalists in South America. But there are exceptions even to this rule. Good work has been done of late years in Buenos Ayres and Parà, and the author of the present volume has not failed to avail himself of the abundant opportunities offered to him for research by the luxuriant fauna and flora of his adopted country. Dr. Herman von Ihering, the energetic director of the Museu Paulista at São Paulo, is well known to us in Europe by his essays on various subjects connected with the distribution of life in different parts of the world, particularly as regards the neotropical region. He has now collected these essays and reprinted them with additions in a uniform shape under the curious title which we give above. "Archhelenis" and "Archinotis" are names invented to designate the two principal continents which the author believes to have existed in the age of the Chalk, as shown in the map at the end of the volume. Three corresponding names (*Archiplata, Archibrasilia,* and *Archiguiana*) are proposed for the ancient bosses from which the whole continent of South America appears to have been developed, and are explained according to the author's views in his essay on the palæogeography of that region.

Three chapters of Dr. von Ihering's volume treat of the geographical distribution of river-mussels, and are also of some importance, as the author is a leading authority on this subject. Written in 1890, they were translated into English and re-published in the *New Zealand Journal of Science.* The fresh-water molluscs of Chili show many points of affinity to those of New Zealand, and the author agrees with Captain Hutton's views that in the Lower Cretaceous period a large Pacific continent must have extended from New Guinea to Chili, and sent out a peninsula to include New Zealand.

Those who are engaged in the study of the difficult problems presented by palæogeography will do well to consult the memoirs collected by the author in the present volume.

*The Moon, a Popular Treatise.* By Garrett P. Serviss. Pp. xii+248; illustrated. (London: Sidney Appleton, 1908.) Price 6s. net.

IN describing the Yerkes photographs of the moon Mr. Serviss has had a pleasant task, and has performed it with pleasing results. The text involves a selenologist, a lady questioner, and the excellent photographs of the moon taken on successive evenings throughout an entire lunation by Mr. Wallace with the 12-inch telescope of the Yerkes Observatory. The author has managed to keep the questions in the background whilst making the answers very lucid and impressive. In an introductory chapter the dialogue turns on the distance, size, motions, &c., of our satellite; thenceforward it takes each photograph of the moon in turn, and gives a simple, straightforward account, in popular language, of the various features, introducing, at well-timed intervals, asides on geometrical, photometrical, and such-like questions. Then follows a chapter (iv) dealing with some of the larger individual features of the lunar surface, as shown on the large-scale photographs taken by Mr. Ritchey with the Yerkes 40-inch refractor.

The exquisite photographs well reproduced—and the easily readable text of this volume should ensure it a welcome from all classes of readers, whether they be astronomers or not. There are twenty-one photographs in the first series and five of the enlarged portions, besides a number of diagrams in the text.

W. E. R.

*The Apodous Holothurians.* By H. L. Clark. Smithsonian Contributions to Knowledge. Part of vol. xxxv. Pp. 231. (Washington: Smithsonian Institution, 1907.)

THE author of this valuable memoir has had the advantage of studying more than two thousand specimens of the species included in the families Synaptidæ and Molpodadiidæ, and he has taken the opportunity of collecting together in the form of a handsome volume the information we possess concerning all the species of this interesting group. There are three coloured and ten monochrome plates of figures, illustrating the form and anatomy of the different species, of which several are original, and the others copied from the works of Semper, Theel, Sluiter, and other zoologists. Eight new genera are described, and a new generic name is proposed for an old genus. The monograph will undoubtedly be of great service to all those who are interested in the study of the Echinodermata.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### Elimination of Self-coloured Birds.

STATISTICAL data on the real value of colour markings in the survival of animals in the field are so uncommon that the publication of the following fragment may be excused.

At the Station for Experimental Evolution, about 300 chicks of from five to eight weeks of age on May 10 were running at large on a well-cropped pasture about three acres in area. For the most part, within the space of less than two hours, twenty-four of these were slaughtered by three crows which were caught in the midst of their work of chasing and killing the young poultry. A close estimate of the fowl as they ran at large shows that about 40 per cent. were of a white plumage, 40 per cent. black or nearly so, and 20 per cent. had a pencilled or striped marking more or less like that of the female jungle fowl or ordinary game. The interesting question arose, Was there any elimination on the ground of colour by the crows? Did any colour favour the escape from observation of any of the chicks?

Were there no selective elimination, expectation on the ground of chance is that of the twenty-four killed 9·6 would be white, 9·6 black, and about five pencilled. *Actually,* there were killed ten whites, thirteen blacks or prevailingly so, and one coarsely mottled grey and buff. No true pencilled bird was killed! The killed birds were largely Leghorns, Minorcas (both good fliers); the pencilled birds were partly games (good fliers), but mostly dark Brahmas (poor fliers). The race is not always to the swift! This fragment, then, so far as it goes, indicates that the self-colours of poultry, which have arisen under domestication, tend to be eliminated by the natural enemies of these birds, and the pencilled birds are relatively immune from attack because relatively inconspicuous.

CHAS. B. DAVENPORT.

Carnegie Institution of Washington, Station for Experimental Evolution, Cold Spring Harbour, N.Y.

### "Barisàl Guns" in Western Australia.

IN NATURE of October 31, 1895, Sir George Darwin, in a letter on "barisàl guns," "mist pouffers," and allied noises, desires all those hearing such to record them from time to time. Recently an instance, which may be of this nature, came under my notice, the only apparent difference being that it was a single noise, and was not repeated several times.

It happened that in July, 1907, I was dispatched by the Government of Western Australia to a remote portion of the north-west of that State to carry out certain investigations. We were camped for two months on the Strelley River (lat. 20° S.)—which only runs in flood-time—sixty miles from Port Hedland, and the same distance from Marble Bar. The situation was a desert "spinifex" plain, with occasional low hillocks of granite boulders, and uninhabited, save by occasional sheep and cattle stations, between the two places mentioned. At approximately 8.35 p.m., mid-West Australian time, on Friday, August 9, I was lying in the tent when, in the words of my diary, "we suddenly heard a dull roar lasting several seconds, increasing in loudness and then decreasing. Everyone heard it and looked round. The sky was quite clear, and there were no signs of thunder clouds. There was no apparent tremor. I thought the noise came from the S.E., others from the N.E. Some suggested it was the rumble of a herd of cattle galloping over a clay pan with hollow ground beneath, as they hear similar noises in the Kimberley District (W. Australia). Mr. G. and I wonder if it is due to a volcanic eruption somewhere, as that of Krakatoa was heard not very far from here." Next day "some men camped twenty miles west from here inquired if we had heard the rumble last night: it appears their Afghans jumped up and said 'buggy coming.' Whatever the sound was, it was not caused by cattle galloping."

The sound resembled a distant, prolonged peal of thunder or the discharge of a far-away piece of ordnance or mine explosion. The nearest working mines would be about sixty miles away, the sea about fifty miles, and it is needless to say there is no artillery within hundreds of miles. No noticeable meteor was seen by anyone, and had the noise been due to this, would it have been heard at places twenty miles apart? It might have been due to an earthquake, but no tremor was noticed.

I have heard from ear-witnesses of dull sounds resembling this being heard in the Kimberley district of this State. At the time, a black-fellow said, "Hill tumble down," and next day they found that great masses of rock had fallen. This might, perhaps, be accounted for in part by the unequal temperatures between day and night—the day very hot, the night very cool. Though the days in August were hot (about 90° F. in the shade) and the nights very cool (requiring several blankets in the early morning), the nearest hill to us was four miles at least away to the east.

Was this, then, an instance of the phenomenon known as "barisàl guns" on the Brahmaputra and "mist pouffers" off Belgium?

Mr. W. E. Cooke, the Government astronomer, to whom I forwarded an account of the phenomenon with the above inquiry, advised me to record it according to the wish of Sir George Darwin. J. BURTON CLELAND.

Department of Public Health, Perth, W. Australia, April 16.

## Welsh Saints and Astronomy.

THERE were in Anglesey two contemporary saints who were in the habit of meeting together at a spot mid-way between their respective abodes. One was called Seiriol Wyn, "Seiriol the White or Bright," the epithet signifying his coming from the east, the region of sunrise. He had his abode on Puffin Island, on the extreme east of Anglesey. The other saint was called Cybi, and because he travelled to meet his friend from the west he was called Cybi Velyn, "Cybi the Yellow." He lived on Holy Island, at Caer Gybi, "Cybi's Camp," the Welsh name of Holyhead. Their place of meeting was in the parish of Llandyvrydog, where there are two springs called Ffynnon Cybi and Ffynnon Seiriol, which are referred to by Matthew Arnold.

> "In the bare midst of Anglesey they show
> Two springs which close by one another play,
> And 'thirteen hundred years agone,' they say,
> 'Two saints met often where these waters flow.'"

Cybi, known in Cornish literature as Kebie, seems to have reached Wales from Cornwall. His wanderings and settlements are curiously coincident with the distribution of the cromlech areas in Wales. On further inquiry one finds that Cybi and Seiriol were regarded as astronomers, and that their places or settlements in Wales may be regarded as observatories.

In an ancient poem, to an extract from which I find the reference "Archaiol. vol. ii. p. 38," they are numbered among the "seven cousin saints," the others being Dewi, Beuno, Dingat, Cynvarch, and Deiniol. "Those are the seven . . . who have been in (or who entered) the Stone (of round form? 'graen grynder'), and the seven who numbered the stars." The expression "a fu'n y Maen," "who have been in the Stone," must be taken in the sense that they had entered a stone chamber or circle, and it is hard to find any meaning to the phrase unless a cromlech or stone circle is meant, especially when read in connection with numbering the stars. Thus it may fairly be taken that the leading saint-astronomers of Wales are spoken of as having made an astronomical use of stone monuments. This inference is confirmed by the fact that the Cybi churches in Wales, and most likely churches associated with the names of the other six saint-astronomers, preserve in their relation to adjoining churches the cromlech astronomy, especially the May-November year. JOHN GRIFFITH.

## Meteors from $\kappa$ Draconis in May.

ON May 31, 10h. 40m., I saw amid the gathering clouds nearly overhead a very short third-magnitude meteor close to its radiant at $193°+74°$. I had never previously remarked any indication of this shower at the end of May or in June, though it seems continued in an intermittent manner from July to December, and on January 19, 1887, I recorded four meteors from $191°+72°$. There is another winter shower near, viz., at $194°+67°$, from which I saw seventeen meteors on December 18–28, 1886.

A bright, doubly observed meteor seen in 1893 by Corder and myself had a radiant at $186°+74°$. This shower is one of the most interesting of those in the circumpolar region. It is, unfortunately, omitted in the diagram of Ursid radiants facing p. 292 in the Gen. Cat. Radiants, vol. liii. of the Memoirs.

The straggling constellation Draco contains many showers, and some of these are visible over long periods. Thus meteors continue to fall from a centre at about $261°+63°$ during the whole year.

Bristol, June 1. W. F. DENNING.

## FORMATION OF GROUND- OR ANCHOR-ICE, AND OTHER NATURAL ICE.

THE formation of ice on the bottom of a river or stream has occasioned much comment and often scepticism in the minds of scientific men. Instead of ice forming on the surface of the water and growing downwards, we find, in circumstances now well understood, ice forming on the bottom and growing upwards. The phenomenon has been observed in all countries where ice is formed, and has been given various names. In Europe it is called ground-ice or bottom-ice (glace-du-fond, grund-eis), but we often find local names, such as ground-gru and lappered-ice. The term anchor-ice evidently originated in America, for the first record of its use seems to be by a writer in the "Encyclopædia Americana," published in 1831. The term is universally used in the United States and in Canada.

There are many early records of the appearance of ground-ice. It was seen by Hales in 1730 in the Thames. Ireland, in his "Picturesque Views" of the Thames, published in 1792, speaks of ground-ice, remarking, "the watermen frequently meet the ice meers or cakes of ice in their rise, and sometimes in the underside enclosing stones and gravel brought up by them ad imo." It was observed in the Elbe as early as 1788, in the Rhine at Strassburg in 1829, and in the Seine, by Arago, in 1830. So much interested was Arago in the ice that, for the benefit of the doubting savants of his time, he published in France, and in the *Edinburgh New Philosophical Journal* for 1833, an account of his observations. Other interesting papers on the same topic were published about that time. In the same Edinburgh journal we find, in 1834, a paper by the Rev. Mr. Eisdale. Two very interesting and instructive papers were published in the Phil. Trans. for 1835 and 1841 by the Rev. James Farquharson, F.R.S., of Alford, of his observations on the Don and the Leochal.

In Canada the formation of anchor-ice has been given much study, largely owing to its great abundance and economic aspect. For the same reason, much attention has been devoted to it in Russia by prominent engineers, notably by M. Leon Wladimirof in his study of the ice conditions in the Neva.

Nowhere can be witnessed a more wonderful sight of the delicate poising of the forces of nature than in a river like the St. Lawrence, with the advent of the winter season. In November, when the temperature of the water arrives at or near the freezing point, the manufacture of ice begins, and for a period of nearly five months the temperature of the water remains almost stationary. During this time a tremendous struggle goes on between water and ice, growing more severe as the air temperature falls further from the freezing point. The outward calm of the ice-bound river gives no indication of the contest beneath, but it is only during the annual spring break-up that the volume of existing ice is realised. At that time the river frees itself from its icy burden in a few days by a mighty shove, which is viewed by thousands along the river shore at a safe distance from the relentless piling of great ice-blocks.

In all the quieter parts of the river, surface-ice forms into a sheet, and protects the water from excessive loss of heat. Wherever the water flows too swiftly for the surface sheet to form, the comparatively warm water is exposed to the winter weather with all its severity. Ice-crystals are produced all along its surface, and are carried under by the currents, to be whirled about for miles, until finally swept under the barrier-ice at the beginning of quiet water. There they rise and become attached to the under-side of the surface sheet, building downwards immense hanging dams, which form as effective a barrier to the flow of the river as so much rock. Winter floods and ice shoves are the result of this packing of the ice, and, in one part of the St. Lawrence, the damming is so complete as to change the course of the river every year. The natives call this fine ice "frazil," meaning cinder-ice, and this term has now come into general use in Canada.

During the ice survey of the river by the Montreal Flood Commission in 1886, it was revealed that the packing of the frazil extended to the bottom in many places, giving an unusual amount of solidity to the surface sheet. In one case, a depth of 80 feet of solidly packed frazil was measured. Hanging dams of the ice are observed to a greater or less extent for a distance of twelve miles below the barrier-ice at the foot of the Lachine Rapids, and the magnitude of the ice accumulation may be realised when it is stated that the winter level of so mighty a river as the St. Lawrence, which is two miles wide at Montreal, is twice as high as in summer.

A careful study of the winter river temperature by means of very delicate instruments has revealed the fact that the formation and growth of the ice is an accompaniment of a minute temperature depression in the water of the order of a few thousandths of a degree. When the temperature equilibrium of water and ice is upset by this minute amount, fresh ice-crystals are formed, and, being supercooled, adhere to anything in their path which is likewise supercooled. In this way large quantities of anchor-ice are formed on the stones and boulders over which the ice-laden water sweeps. The crystals themselves stick together and form frozen masses. When carried through the rack or screen at the intake of a power-house they freeze to it, and rapidly choke the free water-way. They stick to the turbines, and glue the wheels fast in a short time. When the temperature equilibrium of the river is restored, the ice no longer adheres, and a rise of a few thousandths of a degree above the freezing point changes the ice to a mass of a soft and spongy consistency, capable of passing easily through the most delicate machinery.

It may be said that the whole condition which determines the rapid formation of ice in its harmful adhesive condition hinges on this temperature balance in the water. Since this important fact has been recognised, effective means have been devised for the judicious application of heat about the vulnerable parts of a power-house during such time as supercooling exists. There is no need to melt the ice or to warm the total volume of water flowing, so long as the machinery itself is prevented from falling in temperature with the water. The ice is as effective as water in producing a head. What the engineer has to guard against is that the ice does not stick in its passage through the turbines.

Fig. 1 shows the interior of a penstock, or wheel-pit, after it has been completely blocked with frazil ice. At the time of this photograph the stop logs had been introduced at the rack, the water removed, and more than one-half the frazil-ice shovelled out. This condition is a result of the slight supercooling of the machinery by the water. Where artificial heat is used, conditions like this no longer occur.

The greatest factor for preventing this minute supercooling in the water is the absorption of the sun's radiant heat. During the sunny hours of the day no ice troubles are ever experienced, no matter how low the air temperature may be. Nocturnal radiation, on the other hand, is one of the most effective agencies in supercooling the water and objects immersed in it. Anchor-ice is formed by this means in large quantities, and it has been known to grow on the river bottom before the temperature of the water itself had reached the freezing point. During cold, clear nights

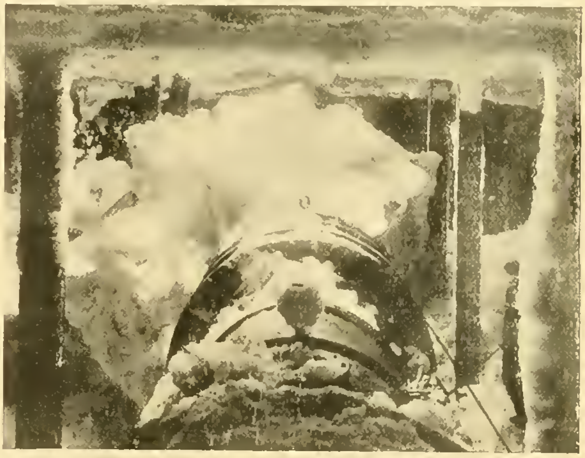


FIG. 1.—Interior of a penstock or wheel pit after the water has been removed, showing the accumulation of adhesive frazil ice.

anchor-ice forms in large quantities. When the air is cold enough to produce supercooling in the water, frazil crystals adhere readily to the anchor-ice and assist in building it up. On cloudy nights, anchor-ice does not usually form, unless the supercooling is great enough to bring the bottom of the river into a supercooled condition. A bridge is found to protect the river bottom from anchor-ice, and even in the severest weather the anchor-ice is always less thick under such a covering.

Anchor-ice is never found to grow under surface-ice. When produced previous to a surface sheet, which in some places does not form until the severest weather, the masses are detached by the natural heat of the earth, and rise to the under-side of the sheet. This has been observed extensively by M. Wladimirof, who has found in such cases an exact correspondence between the line of attached masses under the surface-ice and the river bottom.

Farquharson observed, in the small Scotch streams, that overhanging weeds protect the bottom from the frost, just as a tree will protect the ground from the dew or hoar-frost deposited at night.

The sun's rays are effective in detaching the anchor-ice from the bottom. On a clear morning in winter, as soon as the sun rises, the open surfaces of the St. Lawrence become dotted over with large masses of anchor-ice, which rise high out of the water by the impetus they attain, and sink back with a characteristic noise. Large boulders frozen to the masses are frequently brought up and carried in the currents.

FIG. 2.—Anchor-ice grown up from the rocks and protruding above the surface of the Ottawa river.

When the day is cold and cloudy, anchor-ice does not rise, but builds from the frazil in the water.

Boatmen are careful not to cross the river when anchor-ice is rising for fear of having a mass come up under the boat and carry it helplessly into a rapid or over a waterfall.

The limit of depth below the water-level where anchor-ice will form appears to be roughly about 40 feet, but in the clear waters of the Gulf of St. Lawrence it has been observed as deep as 70 feet. Twenty feet below the surface, anchor-ice will often attain a thickness of 5 or 6 feet during prolonged cold weather. When seen through the water, the growth resembles nothing more closely than the weeds that are found in the shallower portions in summer. Anchor-ice grows in arborescent forms, and with more abundance on dark-coloured rocks, although when it becomes very thick the radiation takes place chiefly from the ice-surface itself. During mild weather, especially with rain, practically all the anchor-ice is detached from the bottom, and this has been shown to accompany a slight temperature elevation in the water above the freezing point.

Fig. 2 shows an ice bridge on the Ottawa River in the process of formation. The anchor-ice may be seen protruding above the water in the shallower parts, and frazil-ice may be seen floating in the current.

Fig. 3 shows the spillway and waste weir of a large power station. Anchor-ice to which frazil has adhered may be seen under the water surface and in places protruding above. The thickness of ice on the crest was from 18 to 22 inches at the time the photograph was taken. In the background men may be seen with long rakes scraping the frazil-ice off the rack-bars or screen through which the water passes to the turbines.

When turbines are operated under very high heads, the supercooling of the water is corrected by the heat generated during the fall and the lowering of the normal freezing point by pressure. Power-houses so situated are seldom troubled with adhesive ice. Many power-houses are fortunately situated so that water is drawn from deep ice-covered channels, where frazil or anchor-ice cannot form, but for nearly all there are times, at the outset of cold weather, before the surface-ice forms, when trouble is encountered. For these and for all water-works situated below permanently open water, steam or electric heating must be resorted to at times, if interruption to the operation is to be avoided.

Through the good work of Mr. John Murphy, M.A.I.E.E., of the Department of Railways and Canals, Ottawa, practical and effective devices are now available for overcoming ice troubles, and in place of expensive auxiliary steam plants for carrying the load during the frazil season, with their corresponding large consumption of coal, a modest steam boiler, or a small amount of electrical energy—usually available in excess—proves an effective means of keeping the plant running smoothly.

To the practical superintendent of a power-house the idea of a thousandth of a degree has little meaning, and yet there is no doubt that the ice problem, as it is presented in the development of "white coal" in northern countries, depends on just such minute changes of temperature.

FIG. 3.—Spillway and waste weir of a power station showing anchor-ice. The thickness of ice on the crest of the spillway is from 18 to 22 inches.

It has been thought that the ice conditions in Canada might detract from the value of the vast water powers available for power purposes, but, from a scientific study of the conditions underlying the formation of ice, it is safe to say that no such bar exists.

H. T. BARNES.

## TELEGRAPHIC PHOTOGRAPHY AND ELECTRIC VISION.

THE success achieved by Dr. A. Korn in the telegraphic transmission of photographs (NATURE, vol. lxxvi., p. 444) has been followed by a remarkable development of inventive activity in the same line. Among several new processes which have recently claimed public attention three of the most promising were described in detail at the April meeting of the Société Française de Physique. As in Dr. Korn's method, the reproduced picture is in all cases constituted by a close spiral line of varying intensity traced upon a photographic film, or other material, covering a cylinder which rotates synchronously with another cylinder in the transmitting instrument. The use of selenium for controlling the resistance of the circuit is, however, generally discarded, the requisite variations of current being effected by purely mechanical means; ordinary film negatives, therefore, cannot be used.

In M. E. Belin's process, which he calls "Téléstéréographie," the original picture is a thickly coated gelatin-bichromate print, which has the form of a relief, lights being represented by elevations of the surface, and shades by depressions. The print is wrapped around the transmitting cylinder, which rotates uniformly, and at the same time moves slowly in a direction parallel to its axis. A sapphire point attached to the short arm of a lever presses lightly upon the picture, and is caused to move in correspondence with the contour of the surface. At the end of the long arm of the lever is a contact piece which slides over the edges of a series of thin copper plates, separated by sheets of mica, and connected with resistance coils, the whole constituting a rheostat capable of interposing in the circuit a resistance ranging from 0 to 4000 ohms in 20 steps. The current, regulated in accordance with the undulations traversed by the sapphire point, passes at the receiving station through an aperiodic reflecting galvanometer, such as Blondel's oscillograph. A beam of light concentrated upon the galvanometer mirror is reflected to a convex lens so placed as to project an image of the mirror over a small hole in the side of a light-tight box, inside which rotates the receiving cylinder covered with a photographic film. Between the hole and the lens, and close to the latter, is inserted an "optical wedge," consisting of a sheet of glass tinted by gradations from perfect transparency at one end to opacity at the other. A slight deflection of the mirror displaces the reflected rays from the centre of the lens towards the edge, and causes them to pass through a different part of the optical wedge; thus the intensity of the projected image of the mirror, and therefore of the photographic action upon the film, is varied in correspondence with the strength of the current. Photographs measuring 13 cm. by 18 cm. were transmitted by this apparatus over a double-wire telephone line in 22 minutes.

For use in Carbonnelle's instrument, the "Téléautograveur," the photograph is submitted to a treatment, details of which are not published, whereby the electrical conductivity is varied locally, being greater in the shades than in the lights. The picture is mounted upon the transmitting cylinder, and a stylus bearing upon the surface is joined to one of the line-wires. The receiving cylinder is covered with a sheet of soft metal, gelatin or celluloid, or simply by several sheets of white paper separated by carbonic paper. The sheet is acted upon by a graving point attached to the diaphragm of a telephone, which is in circuit with the transmitting apparatus. This process is said to give very satisfactory results, and to be remarkably rapid, a portrait 9 cm. by 7 cm. having been reproduced over a distance of 90 kilometres in 88 seconds.

A picture adapted for transmission by M. Pascal Berjonneau's "Téléphotographe" is prepared as a cylindrical half-tone block, the surface consisting of a multitude of metallic points, the density of which varies with the lights and shades. The block rotates under a stylus in the usual way, regulating the current which passes over the line. At the receiving station a galvanometer actuates a shutter which allows more or less light to pass through a small aperture to the photographic film. It is claimed for this apparatus that it is the only one which can be operated satisfactorily on an ordinary telegraph line, all others requiring a telephone line with metallic return. The time occupied in sending a portrait from Paris to Enghien by a single wire is said to have been 247 seconds.

The problem of telegraphic photography is often associated in the popular mind with that of distant electric vision, or "seeing by electricity," as it has been called. According to a telegram from the Paris correspondent of the *Times*, dated April 28, the latter problem is now engaging the attention of M. Armengaud, president of the French Society of Aërial Navigation, who "firmly believes that within a year, as a consequence of the advance already made by his apparatus, we shall be watching one another across distances hundreds of miles apart." It may be doubted whether those who are bold enough to attempt any such feat adequately realise the difficulties which confront them. The telegram referred to seems to contemplate the transmission of optical images over an ordinary telegraph or telephone line by a method in which advantage is taken of visual persistence. A necessary condition would be that the sensitive substance—selenium or other photoelectric body—should pass at least ten times per second over every unit of the surface upon which the image to be transmitted is projected, while at the distant station electrical connection is established, also ten times per second, between the line wire and every individual element in succession of the apparatus illuminating the receiving screen; and the synchronism of the arrangement must be so perfect that at the moment when the sensitive substance occupies any given unit area on the surface of the transmitter, connection must be made with the corresponding unit in the receiver. The difficulty imposed by this condition depends chiefly upon the necessarily large number of the units of area to be dealt with. Suppose that the image is received upon a screen no greater than 2 inches square; if its definition is to be as perfect as that presented by the eye or by a good photograph, the number of elements required would amount to about 150,000, and the synchronised operations to a million and a half in every second. If we are satisfied with a definition equal to that of the coarse half-tone pictures to be found in some of the daily newspapers, the necessary number of elements might be reduced to 16,000, and that of the synchronised operations to 160,000 per second. Even this would be wildly impracticable, apart from other hardly less serious obstacles which would be encountered. The number of operations might, of course, be greatly diminished by employing an oscillating or rotating arm, carrying a row of sensitive selenium cells, as was proposed by Profs. Ayrton and Perry nearly thirty years ago. For a coarse-grained picture 2 inches square 120 of these might suffice; but such an arrangement would require 120 line wires, and would also introduce a new series of troubles.

But although the problem is apparently incapable of solution upon the lines indicated, there is no reason beyond that of expense why vision should not be electrically extended over long distances. The only method which can be regarded as feasible (unless, indeed, M. Armengaud has made a revolutionary discovery) is that suggested by the structure of the eye itself; the essential condition is that every unit area of the transmitter screen should be in permanent and independent connection with the corresponding unit of the receiving screen. This idea would naturally present itself to anyone approaching the subject for the first time, but would probably be rejected in favour of something apparently more simple. Such an apparatus could, however, be constructed without any serious complexity apart from that arising from the mere multiplication of its components. I have made a rough estimate of the cost, assuming the stations to be 100 miles apart, the received picture to be 2 inches square, and the length of a unit to be 1/150 inch. Of each of the elementary working parts—selenium cells, luminosity-controlling devices, projection lenses for the receiver, and conducting wires—there would be 90,000. The selenium cells would be fixed on a surface about 8 feet square, upon which the picture would be projected by an achromatic lens (not necessarily of high quality) of 3 feet aperture. The receiving apparatus would occupy a space of about 4000 cubic feet, and the cable connecting the stations would have a diameter of 8 or 10 inches. The thing could probably be done for 1,250,000*l.*, but not for much less. By an application of the three-colour principle it would be possible to present the picture in natural colours, like that shown upon the focussing screen of a camera. The cost would in that case be multiplied by three.

SHELFORD BIDWELL.

## *ARISTOTLE AND NATURAL SELECTION.*

A PASSAGE of Aristotle's "Physics," in which he alludes to the theory of natural selection, has been frequently quoted and almost as frequently misinterpreted. It may therefore be worth while to devote a short space to a careful consideration of its import.

The passage in question is in the "Physica Auscultatio," ii., 8, §§ 1–6. In it Aristotle begins by asserting the existence in nature of final causes (*ἕνεκά του αἰτία*). He next considers objections that may be brought against this view, as, for example, that rain falls simply in obedience to natural law (*ἐξ ἀνάγκης*) and not for the sake either of making the corn grow or of spoiling it when cut. So, too, the supposed objector proceeds, with the parts or organs of animals; what is to prevent us from saying that the teeth originate in their various forms of incisors and molars simply by the operation of natural law? That they are serviceable respectively for cutting and grinding is not purposeful, but coincidental (*οὐ τούτου ἕνεκα γενέσθαι, ἀλλὰ συμπεσεῖν*). The existence of these apparent adaptations, the objector adds, can be accounted for by the fact that, as Empedocles has pointed out, those organisms that are unfitted for their conditions do not survive, but perish.

It will be seen from the foregoing that Aristotle does not advance the theory of natural selection as part of his own explanation of adaptation in nature, but as a principle that might be used to reinforce an alternative view.

We may now turn to his answer. The objection, he replies, will not hold, because things that arise naturally (*φύσει*) always, or nearly always, come about thus; *i.e.*, like the teeth, already adapted and fit to survive; while beings such as the unadapted monsters imagined by Empedocles originate, if at all, by chance or spontaneously (*ἀπὸ τύχης καὶ του αὐτομάτου*), and are, Aristotle would say, outside the ordinarily observed course of nature. It cannot be alleged, he goes on to point out, that such phenomena as rain and warm weather are altogether dependent on chance or coincidence (*ἀπὸ τύχης οὐδ᾽ ἀπὸ συμπτώματος*). Warm weather is the rule in the dog-days, and rain in winter. Everyone admits that things of this kind are in accordance with the ordinary course of nature; and if they occur in this regular way neither of themselves (like monsters) nor by mere coincidence (like unseasonable rain) it remains that they must exist for some purpose (*ταῦτ᾽ ἕνεκά του ἂν εἴη*). It must then be concluded that final causes exist in reference to natural products (*ἔστιν ἄρα τὸ ἕνεκά του ἐν τοῖς φύσει γιγνομένοις καὶ οὖσιν*).

Whatever may be thought of Aristotle's argument, it is clear that his general object throughout this passage is to defend his doctrine of final causes (it is to be observed that he does not say that final causes are of universal operation). He is unable to fall in with the view of natural selection as propounded by Empedocles, because, as it appears to him, adaptations are produced ready-made; the non-adapted is not merely eliminated, but seldom comes into existence at all. He seems, however, to admit that for those who believe (as he does not) in a purely fortuitous origin of natural objects, the hypothesis of natural selection affords a feasible explanation of adapted structures.

The erroneous views that have been taken of this passage by various writers have been due, I think, to the general failure to recognise that the whole of sections 2, 3 and 4 are devoted to Aristotle's statement of a possible objection to his own opinion. Thus Gomperz ("Griechische Denker," xiv., pp. 103, 104; Leipzig, 1908), although he clearly states Aristotle's position with regard to the Empedoclean monsters, nevertheless quotes the sentence about the rain and the growing corn as if it gave Aristotle's own explanation instead of the plea of an opponent. Osborn ("From the Greeks to Darwin") falls into the same error; the author of a pamphlet (*Αἱ τῶν* Lamarck *καὶ* Darwin *Θεωρίαι παρὰ τῷ Ἀριστοτέλει*), lately published at Athens, has similarly missed the point; nor has Darwin himself escaped the like misapprehension, for which probably the translator on whom he relied was responsible ("Origin of Species," note to "Historical Sketch" in the later editions). On the other hand, the general drift of the passage was rightly appreciated by G. H. Lewes, though the confusion of ideas with which he taxes it belonged, perhaps, rather to his own mind than to that of Aristotle.

F. A. DIXEY.

## *NOTES.*

WE notice with deep regret that Sir John Evans, K.C.B., F.R.S., died at his residence, Britwell, Berkhampsted, on Sunday, May 31, in his eighty-fifth year.

SIR GEORGE DARWIN, K.C.B., F.R.S., and Prof. E. B. Tylor, F.R.S., have been elected corresponding members of the Vienna Academy of Sciences.

THE twenty-fourth Congress of the Royal Sanitary Institute will be held at Cardiff on July 13–18, under the presidency of the Earl of Plymouth. In addition to sectional meetings, there will be a number of conferences on various aspects of sanitary science, among the subjects being spring cleaning and its sanitary significance, and the sorting and grouping of school children for educational purposes.

We learn from the *Times* correspondent at St. Petersburg that on Monday, June 1, the Grand Duke Michael opened the International Congress on Navigation, which is being held for the first time in St. Petersburg. Three thousand delegates from all countries have assembled, including Sir John Murray, K.C.B., F.R.S. Regret is expressed by the organisers of the congress at the small representation of Great Britain.

Under the direction of Prof. Loomis, an exploring party will leave Amherst College, Mass., on June 12 to work in the western States. The party will first examine the Indian quarries in Converse County in search of stone implements, and will then look for horse, camel, and rhinoceros bones in the Lower Miocene in Nebraska. The party will then go southwards to the Upper Miocene of north-eastern Colorado, where it is expected to find the later stages of the same groups of animals. Prof. Lull, of the Yale Museum, will probably camp with this party, but will make an independent collection.

The death is reported, in his fifty-seventh year, of Prof. Leslie Alexander Lee, who held the chair of biology in Bowdoin College, Maine, since 1876. In 1887 he was chief of the scientific staff on the voyage of the U.S. Fish Commission's steamer *Albatross* through the Strait of Magellan. The results of his work on this expedition were preserved in a large number of biological, geological, and ethnological memoirs published by the Smithsonian Institution. He was also director of the Bowdoin expedition to Labrador in 1891, when large collections were made, and the Grand Falls, 316 feet high, were rediscovered.

On May 15 there was held in Cracow, at the Academy of Sciences, a celebration of the twenty-fifth anniversary of Prof. Olszewski's work on the liquefaction of gases, his first researches in that direction having been commenced during the spring of 1883 with the late Prof. Wróblewski. The celebration was an unofficial one, and only the members of the mathematical and natural history class of the academy took part in it. The president of the academy, Prof. Count Tarnowski, congratulated Prof. Olszewski in an address, after which an album containing photos of the members of the mathematical and natural history class was presented to him. As the intention of the academy to celebrate the work of its distinguished member was not publicly made known, only a few letters and telegrams reached him, including those of several learned societies in Warsaw and of the professors of chemistry and of physics in the University of Fribourg.

A poll has just been taken by the Geological Society to ascertain the opinion of the fellows resident in the United Kingdom as to the admission of women to the society. The number of voting papers sent out was 870, and 477 replies were received. An analysis of the votes shows that 248 fellows were in favour of the admission of women as fellows and 217 against their admission, but of this number only 133 voted against the admission of women at all, the remaining eighty-four being in favour of their admission as associates. The fact that there was a majority of thirty-one in favour of the admission of women as fellows should be an encouraging sign to the increasing number of women who are taking up scientific work and in other ways contributing to the extension of natural knowledge.

The council of the Institution of Civil Engineers proposes to award annually a prize, of the value of about 33*l.*, to be called the Indian premium, to the author, being a corporate member of the institution in practice in India, of the best paper received during the year on a subject connected with Indian engineering. The council further proposes that the income of a legacy of 1000*l.* bequeathed by the late Mr. L. F. Vernon-Harcourt to the institution be applied, in general accordance with the testator's wishes, to provide for a biennial lecture on some subject relating to rivers, canals, or maritime engineering, to be delivered before meetings of students of the institution in London and before such of the provincial associations of students as the council may determine from time to time. The council recently accepted, on behalf of the institution, a legacy of 1000*l.*, bequeathed by the late Mr. F. W. Webb, to be applied to establish a "Webb prize" for the best paper submitted to the institution on railway machinery, or upon some branch of railway machinery which may be prescribed.

The thirteenth annual congress of the South-eastern Union of Scientific Societies will be held at Hastings on June 10–13 under the presidency of Sir Archibald Geikie, K.C.B., Sec.R.S., who will give his presidential address at the Royal Concert Hall, St. Leonards, on Wednesday, June 10, at 8 p.m. Papers are promised by Mr. E. A. Martin, on some considerations concerning dew-ponds; Messrs. Ruskin Butterfield and W. H. Bennett, a contribution to the spider fauna of the district round Hastings; Mr. W. H. Mullens, Gilbert White and Sussex; Mr. Edward Connold, local sponges; Mr. J. E. Ray, mediaeval timbered houses of Sussex and Kent; Mr. Wintour F. Gwinnell, the reptile monsters of Mesozoic times, with especial reference to the iguanodon; Mr. Lewis Abbott, Pleistocene vertebrates of the south-east of England; Mr. W. M. Webb, Darwinism as applied to dress. There will be a loan museum under the superintendence of Mr. E. W. Swanton. Excursions, geological or antiquarian, will take place to Hastings Castle and Caves, and the salient physical features of the district, Battle Abbey, Rye, Bodiam Castle, and Dungeness. The local secretary is Mr. W. Ruskin Butterfield, Corporation Museum, Hastings, from whom tickets and all information can be obtained.

Captain Ejnar Mikkelsen has returned, we learn from the *Times*, to Copenhagen after his two years' sojourn in the regions north of Alaska. The chief object of the expedition was to decide whether there is land to the north of Alaska or a deep sea. Captain Mikkelsen's ship arrived on September 17, 1906, at Flaxman Island, where she was soon frozen in. The whole of that autumn was spent in mapping the surrounding country and observing the tide. About forty miles from the coast the party found mountains from 10,000 feet to 12,000 feet in height, hitherto not marked on any map, and Mr. Leffingwell, the companion of Mr. Mikkelsen, undertook some geological researches. In March, 1907, Captain Mikkelsen, Mr. Leffingwell, and the mate started in three sledges with eighteen dogs on a trip over the ice towards the north. The thermometer showed −56° C.; nevertheless, they often came across big crevices among the ice floes. About fifty miles from shore they found water which they sounded to the depth of 800 metres without reaching bottom. Sixty miles further on no change was recorded, until at last, turning towards the south-east, they found bottom. They followed this edge of the continental shelf towards the east, but had soon to return owing to the strong current. Captain Mikkelsen was thus able to prove that deep water exists north of Alaska to a great distance.

On May 31, in Rome, M. Delagrange made successful experiments with his aëroplane. According to the *Times* correspondent, at the request of M. Delagrange the Italian Society of Aviation prepared the ground in the Piazza d'Armi for an officially authenticated trial. The Piazza was marked with flags, the four sides measuring in all 1300 metres. At 5.40 a.m. M. Delagrange set his machine going. The aëroplane ran for fourteen seconds, and then rose easily, remaining in the air for the whole of the rest of the flight, and keeping a distance from the ground varying between three and five metres. The actual flight lasted for 15m. 26s., and during that time the aëroplane made the circuit of the marked course $9\frac{3}{4}$ times. The actual distance travelled, measured by the milometer of an automobile, which naturally took closer curves than the aëroplane, was more than 15 kilometres, or there was a flight through the air without touching ground of 15 kilometres in something more than 15 minutes. M. Delagrange steered and controlled the aëroplane with ease, and could have continued the flight if the power of the engine had permitted. The problem of stability has still to be solved; M. Voisin, who made the aëroplane, hopes to overcome instability by increasing the number of planes. Other trials were made in the evening, in one of which M. Delagrange travelled five times round the Piazza in six minutes at a height of between five and six metres. On June 1 a final trial was made in the presence of the Queen-Mother. In preventing a possible collision with the Royal stands, M. Delagrange stopped the aëroplane too suddenly, and it fell from a height of about four metres to the ground. The aëronaut was unhurt, but the aëroplane sustained slight damage.

Just now, when consideration is being given to a proposal to effect an arrangement which shall ensure the utilisation of a larger number of hours of daylight in the summer time, it is not without interest to direct attention to a paper, which Mr. G. V. Hudson read before the New Zealand Institute in 1898, a copy of which the author has forwarded to us. The scheme differs from that now before a committee of the House of Commons in being of a more drastic character, and being free from the frequent irritating interferences with the regular record of time, which is one of the most objectionable features of the present Bill. Writing for the southern hemisphere, it was proposed to put the clock forward two hours on the first of October, and to put it back the same amount in the following March. Here the scheme has the merit of boldness, and if any breach in continuous time reckoning is to be tolerated, it may be excused on the ground that a considerable advantage is promised. In the paper are discussed the advantages and many of the objections with which we have become familiar from the evidence that has been given before the Parliamentary Committee, and sufficiently reported in the daily Press. There is no necessity to discuss these either as they appear in the original pamphlet or in a more modern dress. To substitute mid-European time as some of the witnesses have suggested is a noticeable improvement on the original plan, and one that would meet many objections. But, notwithstanding the amendment, it may be pointed out that, since the Bill does not contemplate any alteration of time as employed in navigation and nautical matters, one can conceive that in seaport towns, where the influence of shipping makes itself felt in the general conduct of business, very considerable confusion can arise. For instance, in most seaport towns a time signal is used for the convenience of vessels in port. That signal is also valuable to the public, and serves to regulate time. It seems that under the Bill the interests of one party must be sacrificed. Either the seaman or the public loses the time signal. It is easy to say that is a mere detail, but the whole objection to the scheme turns on details, and the final acceptance or rejection of the Bill will depend on the importance that details may acquire by accumulation.

The Alliance Franco-Britannique, Littéraire, Scientifique, et Artistique, held a conversazione at the Grafton Galleries, Grafton Street, London, on May 28, in the course of which M. Yves Guyot delivered a lecture on "Les Rapports Intellectuels de la France et de l'Angleterre." Sir Archibald Geikie, K.C.B., F.R.S., chairman of the council, introduced the lecturer. Referring to French and English science, M. Yves Guyot said, from the point of view of pure science, the English have changed the French system of natural science completely. In France the theocratical conceptions of Cuvier's "Révolutions du Globe" were still held when in 1830–3 Charles Lyell substituted for them the real and conclusive theory of "actual causes." The Frenchmen Lamarck and St. Hilaire had anticipated evolution, but when in 1858 Darwin expounded the theory of the struggle of life he brought about a total transformation in the study of biology. Herbert Spencer boasted of having given a systematic explanation of the universe, and of having propounded the conditions of evolution. Almost all his works have been translated into French, and they have continued to exercise upon French thought the beneficent influence which all English thinkers since Locke have had over it. Almost all Frenchmen are sons of Plato, who are apt to take words for deeds. University literary teaching in France has encouraged this tendency. This method of procedure allows scope, on one hand, for all the subtleties of scholasticism, and on the other for all the literary and oratorical explanations which hide the emptiness of the idea under assertions and metaphors. The English mistrust generalisations, and make a constant appeal to facts. They have the primary qualification for all scientific research—honesty. They do not try to dazzle by sophistry; their objective is truth, and by their example they force the men of research in all countries to subordinate all other considerations to this end. Not only have they enriched the world with the experimental method, but they make everyone practise it conscientiously. Hence it is easy to recognise in France those authors, professors, publicists, and *savants* who have come under English influence. Later, M. Yves Guyot remarked that among the useful forms under which English influence has been exerted upon the French intellect, the first is scientific. Bacon against Plato, Newton against Descartes, Lyell against Cuvier; the movement was continued through Darwin and Herbert Spencer. It was confirmed also by Adam Smith. It is the inductive method as opposed to intuitive conceptions. It is reality opposed to the assertions and subtleties taught by the Greek sophists.

From the East Kent Scientific and Natural History Society we have to acknowledge the receipt of a copy of the report and transactions for 1907.

Fishes of the Rocky Mountain region form the subject of the only zoological paper—by Prof. T. D. A. Cockerell—in No. 3 of the fifth volume of the University of Colorado Studies. Extinct as well as living species are discussed, and it is pointed out that the contrast between the generic types respectively characteristic of the Gila and the Rio Grande basins suggests re-consideration of the theory of a recent depression of the continent in the region of southern New Mexico and Arizona.

The second part of vol. xx. of the Proceedings of the Royal Society of Victoria contains two papers on the geology and palæontology of that colony, Prof. E. W. Skeats discussing the Palæozoic strata of Mooroodue, in the Mornington peninsula, while Mr. F. Chapman describes a number of new or little-known Victorian fossils. The same issue contains the first part of a paper by Miss Georgina Sweet on the anatomy of certain Australian amphibians, of which we have been favoured by the author with a separate copy.

To the May number of the Zoologist Mr. Charles Oldham contributes a paper on the birds frequenting the well-known "gullery" at Ravenglass, on the Cumberland coast. The most notable species nesting there are the black-headed gull and the common and the Sandwich tern, of which the last-named is more numerously represented than in any other of its few English breeding-places. The Sandwich terns breed in colonies of from five or six to fifty or more pairs. These colonies, often at some distance from one another, are chiefly in the southern part of the gullery, and most frequently on the dunes next the sea or the estuary. There the nests are grouped within a few inches of one another, sometimes hard by those of the common terns and the black-headed gulls. Unlike those of the latter, the nests are never in thick herbage, but take the form of mere shallow depressions, with or without a lining of bents, amid the sparse marram-grass.

The first part of the third volume of the Journal of the Federated Malay States Museum is devoted to an account of the exploring expedition to Gunong Tahan, the great mountain to the northward of Pahang, undertaken in 1905 by Messrs. Wray and Robinson, followed by descriptions of the zoological collections. The narrative, which is illustrated by reproductions of photographs of the general scenery and the vegetation, shows that the explorers had to undergo some rough experiences, although the admirable arrangements made by the authorities in the matters of supply and carriage prevented the occurrence of any difficulties. The collections, so far at any rate as vertebrates are concerned, proved, perhaps, a little disappointing. The new mammals, for example, comprised only a couple of squirrels, one of which is merely a subspecies, and a bat, albeit of a rather rarely represented genus, while of new birds there were seven, among which a woodpecker (Gecinus), an owl (Heteroscops), and a Cissa are, like one of the squirrels, illustrated in coloured plates.

The sensory reactions of the lancelet are discussed by Mr. G. H. Parker in vol. xliii., No. 16, of the Proceedings of the American Academy of Arts and Sciences. The creature, it seems, is but very slightly receptive to light, responding, indeed, to a rapid increase of illumination, but taking scarcely any notice of a corresponding decrease; the only known light-receiving organs are the eye-cups in the wall of the nerve-tube. Temperatures below 5° C. and above 39° C. are fatal to its existence. Mechanical stimulants affect the skin, more especially the tentacles and oral hood, and sound-vibrations likewise produce an effect on the organism. Tactile organs exist in the skin, but there are no derived structures corresponding to ears and the lateral line of fishes. To locomotion-inducing stimulants the lancelet responds by forward movements when these are applied to the tail, and by backward movements when they touch the middle or fore-part of the body. The creature generally buries itself tail-first in the sand, and probably swims in a similar manner, although in both cases the movement may be reversed.

To the May number of the *American Journal of Science* Mr. R. S. Lull contributes an interesting paper on the head-muscles of dinosaurs, with special relation to the origin of the neck-shield in the horned group (Ceratopsia). Such evidence as can be obtained with regard to the cranial musculature can, of course, be gleaned only from the form and proportions of the skull, coupled with, in some cases, the marks of the attachments of the muscles themselves. From the analogy of chamæleons, which, although insectivorous, masticate their food, it is inferred that horned dinosaurs had powerful temporal and feeble pterygoid muscles, thereby differing markedly from crocodiles, in which, owing to the absence of mastication, the conditions in these respects are reversed. It is also pointed out that the neck-shield or frill of the Ceratopsia presents a remarkable analogy or parallelism to the so-called casque of the chamæleon's skull, both structures being essentially a backward extension of the parietal segment designed to afford extra space for the origin of the great temporal muscles. It is added that Owen's chamæleon from the Cameroons presents a curious "mimicry" of the Triceratops type in carrying three horns situated very much as in the dinosaur, although these horns are entirely dermal structures, devoid of bony cores. "In the chamæleon they seem to be the result of sexual selection, and are certainly not for aggressive warfare in a creature which moves with the utmost caution; while in Triceratops the presence of efficient weapons in both sexes was an imperative factor in the struggle for existence."

In the *Travaux de la Société Impériale des Naturalistes de St. Pétersbourg* (vol. xxxviii., part i.) there appear two contributions to the "Flora Caucasica Critica." Mr. N. Kusnezow contributes addenda and a summary of various cohorts allied to the Ericales, and Mr. A. Fomin is responsible for a fascicle on the Campanulatæ.

The first number of the Proceedings of the Field Club and Natural History Society of University College, Exeter, has been received, in which the inception of the Field Club and records for previous years are chronicled. A list of plant formations on Dawlish Warren is contributed by Mr. J. L. Sager. Mr. J. Stevens supplies a catalogue of Rotifera collected in the Exeter district, among them a new species, *Brachionus sericus*, taken on Hell Tor.

A pamphlet dealing with the red-rot of the sugar-cane stem is issued as Bulletin No. 8 from the experiment station of the Hawaiian Sugar Planters' Association. Up to the present this disease, that is ascribed with a tolerable degree of certainty, although not quite definitely, to *Colletotrichum falcatum*, has not been credited with causing much damage in the Hawaiian Islands, so that the account is in the nature of a premonitory warning. Being a wound parasite, the fungus enters readily where the canes have been penetrated by borers, and is liable to be perpetuated by planting of diseased canes. A resistant variety appears to have been found in the yellow Caledonia.

The short list of new diagnoses, "Decades Kewenses, xxiii.," published in the current number of the *Kew Bulletin* (No. 4), contains Chinese species of Sterculia, Euonymus, and Rheum, also a new Rheum from Tibet. Mr. J. Burtt-Davy communicates some notes on Transvaal trees and shrubs. The group of Acacias is very numerous, and includes the species *caffra, Catechu, Giraffae, horrida,* and *spirocarpoides*, the last-named being a common species of the "umbrella" type in the Waterberg district. Evidence is adduced in favour of referring the Pretoria

"Wonderboom" to *Ficus caffra*. The determination of species in the orders Rubiaceæ, Ebenaceæ, and Celastraceæ is provisional. On the subject of the South African locust fungus, *Entomophthora Grylli*, Mr. G. Massee concurs in the opinion that it does not provide a remedy for exterminating locusts. Mr. T. A. Sprague collates the information regarding the occurrence of rubber in species of Gymnosporia.

Mr. R. G. Thompson, in the May number of *Man*, describes the ancient gold mines at Gebét, in the eastern Sudan, some eight days' march from Suákim. The works on this site, which is still occupied by miners, consist of an extensive series of underground tunnels excavated with metal tools, such as an iron scraper found in one of the workings. The scanty remains of pottery found indicate that these mines were worked about the beginning of the Christian era. The most noticeable relics are a number of querns of a rude form in which the quartz was ground, the gold being subsequently extracted by the action of water.

In the April number of the Journal of the Gypsy Lore Society Dr. G. A. Grierson contributes an interesting note on the philology of Romani. The Indian Gypsies, most of whom are of south Indian origin, have little to do with it, although some of them have borrowed words which are closely connected with it. He accepts Prof. Peschel's suggestion that the linguistic home of the Romani is to be found mostly beyond the northern frontier of India, in Kashmir, Gilgit, and Chitral, among the Doms of that region. Their language is one of the Pisáca group, a name which represents an Aryan tribe which reached India from the Pamirs over the Hindu Kush. As they entered the Punjab their speech became partially mixed with those of the other Aryan tribes who entered India from the west, but it can still be traced down the Indus valley into Sind, across Gujarat into the country of the Bhils, and as far as the central Vindhyan range, where it has affected the local dialects of Mahratti.

The *Australasian Traveller*, the journal of the Commercial Travellers' Association of Australasia, issued as its last Christmas number a richly illustrated folio volume of nearly 200 pages entitled "Australia To-day." It contains accounts of the resources, industries, and attractions of each of the Australian States and of British New Guinea. It directs attention to the enormous value of Australian production, with its output of 474,000,000*l*. of gold and its pastoral and agricultural produce, which together give it a greater output per head of population than any other continent. In addition to a collection of recent statistics, it describes pictorially the working life of the Australians and their industries, and the series of large photographs gives an excellent idea of the varied and beautiful character of Australian scenery.

It is stated in the *Engineer* of May 29 that in sinking for the sump at the new collieries at Bentley, near Doncaster, where the Barnsley seam was reached six weeks ago at a depth of 624 yards, a further fine seam of coal has been discovered twenty-four yards below the Barnsley seam. It is 5 feet thick, and is known in Derbyshire as the Dunsil seam. Hitherto it has not been found in workable thickness in Yorkshire.

The new museum of safety devices installed in December, 1905, at the Conservatoire des Arts et Métiers, in Paris, is described by Mr. J. Boyer in the *Engineering Magazine* for May. Its purpose is to indicate the precautions to be taken and the devices to employ to protect workmen against risks of all kinds—unhealthy atmosphere, dangers from machinery, harmful dust, high electric voltages, and poisoning.

The summary of the weather for the closing week of May, issued by the Meteorological Office, shows that the conditions had generally become more settled and summer-like over the entire country. In the north of Scotland the shade temperature rose to 80°, and almost equally high temperatures occurred generally over the United Kingdom. The spring, covered by the period of thirteen weeks ending May 30, was wet over the entire country, the aggregate rainfall being everywhere in excess of the average. In the north-west of England and in the Midland counties the excess of rain was more than 2 inches, and the number of rainy days was everywhere more than the normal. The temperature for the season was below the average, and there were fewer hours of bright sunshine than the normal. June opened with high summer temperatures, and sharp thunderstorms were experienced on the night of June 1 in most parts of England.

Dr. F. Eredia, of the Meteorological Office at Rome, continues in the Bulletin of the Italian Aëronautical Society his useful discussion of the winds of Italy, for places where trustworthy observations are available for the years 1891–1900. We have received memoirs relating to five provinces, in which he deals with the frequency of wind-direction referred to eight points, for months and seasons, illustrated by diagrams and wind-roses. In all cases the principal results are summarised in an interesting textual discussion.

We have recently received from Prof. Hergesell a copy of the observations relating to the meteorological service of Alsace-Lorraine for 1903, one of the series of year-books published on a uniform plan by the various States of the German Empire. The tables include monthly and yearly results for a large number of stations, hourly means for Strassburg, and five-day means at fourteen selected places. There is also a valuable appendix by Dr. Kleinschmidt containing monthly and yearly rainfall values for lustra, extending in some cases from 1876 to 1905. Some of these data have been compiled from Dr. Hellmann's great rainfall work and other trustworthy publications.

The May number of the *Jahrbuch der Drahtlosen Telegraphie und Telephonie* contains two contributions by Prof. J. A. Fleming and Dr. L. Mandelstam, respectively, to the discussion as to the correct deduction and interpretation of Prof. Fleming's formula for the radiation in different directions of the bent antennæ used in wireless telegraphy.

The *Physikalische Zeitschrift* for May 15 contains an article on the daily variation of the potential gradient in the atmosphere, by Dr. D. Smirnow, of the Central Observatory of St. Petersburg. He shows that the daily variation on clear days may be explained, qualitatively at least, and possibly quantitatively, by the production at sunset of a colder and relatively moist stratum of air in contact with the ground, which, owing to the reduced mobility of the ions and consequent decrease of electrical conductivity, causes positive electricity to collect on the ground, and thus reduces the electric field above the cool layer. At sunrise the layer disappears and the field increases to its former value. During the day the ascending air carries with it positive electricity, leaving negatively charged dust particles behind, and so the field is reduced. The direct action of sunlight in producing negative charges in the upper atmosphere seems to have little effect on the potential gradient near the surface.

## OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JUNE:—

June 6. 5h. 37m. to 9h. 20m. Transit of Jupiter's Sat. III. (Ganymede).
7. 4h. 24m. Conjunction of Mercury and Mars. Mercury 0° 19′ N.
,, 13h. 0m. Mercury at greatest elongation, 23° 58′ E.
13. 9h. 57m. to 13h. 39m. Transit of Jupiter's Sat. III. (Ganymede).
14. 10h. 13m. to 11h. 24m. Moon occults 4 Sagittarii (mag. 4·6).
19. 11h. 10m. Minimum of Algol (β Persei).
21. 8h. 19m. Sun enters Cancer and Summer commences.
22. 8h. 32m. Venus in conjunction with Mars, Venus 2° 4′ S.
28. Eclipse of the Sun partially visible at Greenwich. Begins 5h. 14m.; Middle 5h. 38m.; Ends 6h. 2m. Magnitude (Sun's diameter = 1) 0·065. At the time of greatest obscuration nearly one-fifteenth of the Sun's southern limb will be occulted.

THE RETURN OF ENCKE'S COMET.—A telegram from the Kiel Centralstelle announces that Encke's comet was found by Mr. Woodgate, of the Cape Observatory, on May 27. Its position at 17h. 49m. (Cape M.T.) on that date was R.A. = 2h. 59·3m., dec. = 7° 29′ S. This is situated about half a degree north of ρ Eridani, and is, at present, unobservable in these latitudes.

THE RADIAL VELOCITY OF ALGOL.—No. 22, vol. ii., of the *Mitteilungen der Nikolai-Hauptsternwarte zu Pulkowo* contains a very full discussion by Prof. Belopolsky of the radial-velocity observations of Algol made at the Pulkowa Observatory during the years 1905–7. The results obtained from each line on each spectrogram are discussed in detail, and the following elements are finally derived:— $\omega$ 42°·5 ± 1°·35, $e$ = 0·0476 ± 0·0037, T = 2·509 ± 0·00019 days, $a$ = 1,693,523 ± 100 km., and $i$ = 90°.

THE RADIAL VELOCITY OF ε URSÆ MAJORIS.—From two spectrograms obtained at Potsdam in 1889, Profs. Vogel and Scheiner found the radial velocity of ε Ursæ Majoris to be −30·4 km., the measurements being made on the Hγ line. But from nine very consistent plates, secured with the Bruce spectrograph in 1902–3, Prof. Adams derived the value −9·4 km., and in 1903 this was confirmed by measurements of seven plates obtained at Potsdam, the mean value being −9 km. Vogel and Eberhard then re-measured the original plates, and confirmed the first value. The comparison of these results suggested that, possibly, the radial velocity of ε Ursæ Majoris is variable. That the star is of peculiar interest is shown by the fact that its spectrum is given as type I. *a* 2 in Vogel's classification, as VIII. P. in the Harvard classification, and that Sir Norman Lockyer, whilst classing it as "Sirian," has pointed out that it has several well-marked peculiarities.

For these reasons Messrs. Baker and Schlesinger, of Allegheny Observatory, obtained—during March and April, 1907—and the former measured, seven spectrograms taken with the Mellon spectrograph, which gives a measurable spectrum of 21 mm. in length between λ 3925 and λ 4750. The resulting mean value was −7·1 km. ±0·46 km., and as this agrees so closely with that obtained by Prof. Adams and with the later value of Prof. Vogel, the matter must still be considered as requiring further investigation (Publications of the Allegheny Observatory, vol. i., No. 4, p. 23).

OBSERVATIONS OF JUPITER'S SATELLITES.—Some interesting observations of eclipses and occultations of Jupiter's satellites are recorded by M. S. Kostinsky in No. 4249 of the *Astronomische Nachrichten* (p. 14, May 20). On April 3 photographic and visual observations of a partial eclipse of J. ii. by the shadow of J. i. were secured; the brightness of J. ii. was diminished about 0·3–0·4 magnitude according to the eye observations, and the minimum brightness occurred at 11h. 52·3m. (Pulkowa M.T.). On February 24 an occultation of the second satellite by the first was observed at 10h. 45·5m., and on March 27 and 30 two series of photographs of the second and third satellites were secured during their eclipse by the planet's shadow.

A partial eclipse of the second by the third satellite was observed by Herr Fauth at the Landstuhl Observatory at 8h. 17m. 55s. (M.E.T.) on February 20.

THE ORBIT OF α ANDROMEDÆ.—The following elements for the orbit of α Andromedæ are published by Mr. Baker in vol. i., No. 3, of the Publications of the Allegheny Observatory (pp. 17–22):—P = 96·67 days, $e$ = 0·525, T = 1907 November 2·40, $\omega$ = 76°·21, K = 30·75 km., $\gamma$ = −11·55 km., A = 34·60 km., B = 26·90 km., and $a \sin i$ = 34,790,000 km. The discussion of the orbit was based on the measures of eleven lines between λ 3933·789 and λ 4481·437 on ninety-four plates obtained with the Mellon (single-prism) spectrograph, and the results are compared with those previously obtained at the Lowell, Lick, and Potsdam observatories.

THE UNITED STATES NAVAL OBSERVATORY.—The annual report of the United States Naval Observatory for the fiscal year ending June 30, 1907, gives the usual data regarding the time-service, publications, &c., and a brief summary of the observations made with each set of instruments. The observation of each star in Sir David Gill's Zodiacal Catalogue of 2798 stars was nearly complete, but a few more observations remained to be made in the autumn of 1907. More than 3000 observations were made by different observers with the new self-registering transit micrometer installed in October, 1906, and the results again prove the efficiency of this instrument. Bad weather limited the number of photoheliograms obtained, records being secured on only 150 days; spots were shown on the negatives on 148 days. There are now 1455 solar negatives in hand, and in order to minimise the labour of reducing these it is proposed that a heliomicrometer, as devised by Prof. Hale, be installed.

## ON THE SHAPES OF EGGS, AND THE CAUSES WHICH DETERMINE THEM.[1]

THE eggs of birds and all other hard-shelled eggs, such as those of the tortoise and the crocodile, are normally simple solids of revolution, but they differ greatly in form according to the configuration of the plane curve by the revolution of which the egg is, in a mathematical sense, generated. Some few eggs, such as those of the owl or of the tortoise, are spherical or very nearly so; a few, such as the grebe's or the cormorant's, are approximately elliptical, with symmetrical or nearly symmetrical ends; the great majority, like the hen's egg, are ovoid, a little blunter at one end than the other; and some, by an exaggeration of this lack of antero-posterior symmetry, are blunt at one end but characteristically pointed at the other, as is the case in the egg of the guillemot and puffin, the sandpiper, plover, and curlew.

Various theories, based upon the principles of natural selection, are current and are very generally accepted to account for these diversities of form. The pointed, conical egg of the guillemot is generally supposed to be an adaptation advantageous to the species in the circumstances under which the egg is laid; the pointed egg is less apt than a spherical one to roll off the narrow ledge of rock on which this bird lays its solitary egg, and the more pointed the egg so much the fitter and likelier is it to survive. The fact that the plover or the sandpiper, breeding in very different situations, lays eggs that are also conical elicits another explanation, to the effect that the conical form permits the many large eggs to be packed closely under the mother-bird. The round egg of the tortoise and the elongated egg of the crocodile have been supposed to be developed in conformity with the shape of the creature that has afterwards to be hatched therein. Whatever truth there be in these apparent adaptations to existing circumstances, it is only by a very hasty logic that we can accept them as a *vera causa* or adequate explanation of the facts; and it is obvious to my mind that, in attempting to deal with the forms assumed by matter, whether in the organic or the inorganic world, we ought first to attempt to deal on simple physical lines with the forces to which it has been subjected, that is to say, the intrinsic forces of growth

1 A paper read before the Zoological Society of London on April 28 by Prof. D'Arcy Wentworth Thompson, C.B.

acting from within and the forces of tension and pressure that may have acted from without.

Certain elementary points in regard to the formation of the egg must be borne in mind :—

(1) The "egg," as it enters the oviduct, consists of the yolk only, enclosed in its vitelline membrane. As it passes down the first portion of the oviduct, the white is gradually superadded, and becomes in turn surrounded by the "shell-membrane." About this latter the shell is secreted, rapidly and at a late period.

(2) Both the yolk and the entire egg tend to fill completely their respective membranes, and, whether this be due to growth or imbibition on the part of the contents or to contraction on the part of the surrounding membranes, the resulting tendency is for both yolk and egg to be, in the first instance, spherical, unless otherwise distorted by external pressure.

(3) The egg is subject to pressure within the oviduct, which is an elastic, muscular tube, along the walls of which pass peristaltic waves of contraction. These muscular contractions may be described as the contraction of successive annuli of muscle, giving annular (or radial) pressure to successive portions of the egg; they drive the egg forward against the frictional resistance of the tube, while tending at the same time to distort its form. While nothing is known, so far as I am aware, of the muscular physiology of the oviduct, it is well known in the case of the intestine that the presence of an obstruction leads to the development of violent contractions in its rear, which waves of contraction die away, and are scarcely if at all propagated in advance of the obstruction.

(4) It is known by observation that a hen's egg is always laid blunt end foremost.

(5) It can be shown, at least as a very common rule, that those eggs which are most unsymmetrical, or most tapered off posteriorly, are also eggs of a large size relatively to the parent bird. We may accordingly presume that the more pointed eggs are those that are large relatively to the tube or oviduct through which they have to pass, or, in other words, are those which are subject to the greatest pressure while being formed or shaped. So general is this relation that we may go still further, and presume with great plausibility in the few exceptional cases (of which the apteryx is the most conspicuous) where the egg is relatively large though not markedly unsymmetrical, that in these cases the oviduct itself is in all probability large (or perhaps weak) in proportion to the size of the bird. In the case of the common fowl we can trace a direct relation between the size and shape of the egg, for the first eggs laid by a young pullet are smaller, and at the same time are much more nearly spherical than the later ones; and, moreover, some breeds of fowls lay proportionately smaller eggs than others, and on the whole the former eggs tend to be rounder than the latter.

We may now proceed to inquire more particularly how the form of the egg is controlled by the pressures to which it is subjected.

The egg, just prior to the formation of the shell, is, as we have seen, a fluid body, tending to a spherical shape and *enclosed with a membrane*.

Our problem, then, is: Given a practically incompressible fluid, contained in a deformable capsule, which is either (*a*) entirely inextensible, or (*b*) slightly extensible, and placed in a long elastic tube the walls of which are radially contractile, to determine the shape under pressure.

(1) If the capsule be spherical, inextensible, and completely filled with the fluid, absolutely no deformation can take place. The few eggs that are actually or approximately spherical, such as those of the tortoise or the owl, may thus be alternatively explained as cases where little or no deforming pressure has been applied prior to the solidification of the shell, or else as cases where the capsule was so little capable of extension and so completely filled as to preclude the possibility of deformation.

(2) If the capsule be not spherical, but be inextensible, then deformation can take place under the external radial compression, only provided that the pressure tends to make the shape more nearly spherical, and then only on the further supposition that the capsule is also not entirely filled as the deformation proceeds.

In other words, an incompressible fluid contained in an inextensible envelope cannot be deformed without puckering of the envelope taking place.

Let us next assume, as the conditions by which this result may be avoided, (*a*) that the envelope is to some extent extensible, or (*b*) that the whole structure grows under relatively fixed conditions. The two suppositions are practically identical with one another in effect.

(3) It is obvious that, on the presumption that the envelope is only moderately extensible, the whole structure can only be distorted to a moderate degree away from the spherical or spheroidal form.

(4) At all points the shape is determined by the law of the distribution of *radial pressure within the given region of the tube*, surface friction helping to maintain the egg in position.

(5) If the egg be under pressure from the oviduct, but without any marked component either in a forward or backward direction, the egg will be compressed in the middle, and will tend more or less to the form of a cylinder with spherical ends. The eggs of the grebe, cormorant, or crocodile may be supposed to receive their shape in such circumstances.

(6) When the egg is subject to the peristaltic contraction of the oviduct during its formation, then from the nature and direction of motion of the peristaltic wave the pressure will be greatest somewhere behind the middle of the egg; in other words, the tube is converted for the time being into a more conical form, and the simple result follows that the anterior end of the egg becomes the broader and the posterior end the narrower.

(7) With a given shape and size of body, equilibrium in the tube may be maintained under greater radial pressure towards one end than towards the other. For example, a cylinder having conical ends, of semi-angles $\theta$ and $\theta'$ respectively, remains in equilibrium, apart from friction, if $p\cos^2\theta = p'\cos^2\theta'$, so that at the more tapered end where $\theta$ is small $p$ is large. Therefore the whole structure might assume such a configuration, or grow under such conditions, finally becoming rigid by solidification of the envelope. According to the preceding paragraph, we must assume some initial distribution of pressure, some squeeze applied to the posterior part of the egg, in order to give it its tapering from. But, that form once acquired, the egg may remain in equilibrium both as regards form and position within the tube, even after that excess of pressure on the posterior part is relieved. Moreover, the above equation shows that a normal pressure no greater and (within certain limits) actually less acting upon the posterior part than on the anterior part of the egg after the shell is formed will be sufficient to communicate to it a forward motion. This is an important consideration, for it shows that the ordinary form of an egg, and even the conical form of an extreme case such as the guillemot's, is directly favourable to the movement of the egg within the oviduct, blunt end foremost.

(8)[1] The mathematical statement of the whole case is as follows:—In our egg, consisting of an extensible membrane filled with an incompressible fluid and under external pressure, the equation of the envelope is $p_n + T\left(\frac{1}{r} + \frac{1}{r'}\right) = P$, where $p_n$ is the normal component of external pressure at a point where $r$ and $r'$ are the radii of curvature, T is the tension of the envelope, and P the internal fluid pressure. This is simply the equation of an elastic surface where T represents the coefficient of elasticity; in other words, a flexible elastic shell has the same mathematical properties as our fluid, membrane-covered egg.

The above equation is the *equation of equilibrium*, so that it must be assumed either that the whole body is at rest or that its motion while under pressure is not such as to affect the result. Tangential forces, which have been neglected, could modify the form by alteration of T. In our case we must, and may very reasonably, assume that any movement of the egg down the oviduct during the period when its form is being impressed upon it is very slow, being possibly balanced by the advance of the peristaltic wave which causes the movement, as well as by friction.

The quantity T is the tension of the enclosing capsule—

[1] The mathematical statement is not my own; I am indebted for it and for other help in the editing of this paper to my colleague, Prof. W. Peddie.

the surrounding membrane. If T be constant or symmetrical about the axis of the body, the body is symmetrical. But the abnormal eggs that a hen sometimes lays, cylindrical, annulated, or quite irregular, are due to local weakening of the membrane, in other words, to asymmetry of T. Not only asymmetry of T, but also asymmetry of $p_n$, will render the body subject to deformation, and this factor, the unknown but regularly varying, largely radial, pressure applied by successive annuli of the oviduct, is the essential cause of the form, and variations of form, of the egg. In fact, in so far as the postulates correspond near enough to actualities, the above equation is the equation of *all eggs* in the universe. At least this is so if we generalise it in the form $p_n+\frac{T}{r}+\frac{T'}{r'}=P$ in recognition of a possible difference between the principal tensions.

(9) In the case of the spherical egg it is obvious that $p_n$ is everywhere equal. The simplest case is where $p_n=0$, in other words, where the egg is so small as practically to escape deforming pressure from the tube. But we may also conceive the tube to be so thin-walled and extensible as to press with practically equal force upon all parts of the contained sphere.

(10) If while our egg be in process of conformation the envelope be free at any part from external pressure (that is to say, if $p_n=0$), then it is obvious that that part (if of circular section) will be a portion of a sphere. This is not unlikely to be the case actually or approximately at one or both poles of the egg, and is evidently the case over a considerable portion of the anterior end of the plover's egg.

(11) In the case of the conical egg with spherical ends, as is more or less the case in the plover's and the guillemot's, then at either end of the egg $r$ and $r'$ are identical, and they are greater at the blunt anterior end than at the other. If we may assume that $p_n$ vanishes at the poles of the egg, then it is plain that T varies in the neighbourhood of these poles, and, further, that the tension T is greatest at and near the small end of the egg. It is here, in short, that the egg is most likely to be irregularly distorted or even to burst, and it is here that we most commonly find irregularities of shape in abnormal eggs.

(12) If one portion of the envelope were to become practically stiff before $p$ ceases to vary, that would be tantamount to a sudden variation of T, and would introduce asymmetry by the imposition of a boundary condition in addition to the above equation.

(13) Within the egg lies the yolk, and the egg is invariably spherical or very nearly so, whatever be the form of the entire egg. The reason is simple, and lies in the fact that the yolk is itself enclosed in another membrane, between which and the outer membrane lies a fluid the presence of which makes $p_n$ for the inner membrane practically constant. The smallness of friction is indicated by the well-known fact that the "germinal spot" on the surface of the yolk is always found uppermost, however we may place and wherever we may open the egg; that is to say, the yolk easily rotates within the egg, bringing its lighter pole uppermost. So, owing to this lack of friction in the outer fluid, or white, whatever shear is produced within the egg will not be easily transmitted to the yolk, and, moreover, owing to the same fluidity, the egg will easily recover its normal sphericity after the egg-shell is formed and the unequal pressure relieved.

## *GEODETIC INVESTIGATIONS IN THE UNITED STATES.*[1]

THE report of the U.S. Coast and Geodetic Survey for 1907 has just been received. For the details of the extensive cartographic work of the bureau in the United States proper, Alaska, Porto Rico, and the Philippines, as well as for the account of the progress of the primary triangulation and levelling of precision, the report itself must be consulted. Certain important work of the survey receives bare mention, as, for instance, the results of the investigation of the earth's figure, based on geodetic operations in the United States. This is owing to the fact that these results were communicated to the International Geodetic Association in a preliminary report which has been published.

Soon after the California earthquake of April 18, 1906, it became evident that the permanent horizontal displacements of large areas covered by triangulation in California had so changed the lengths and directions of the lines joining the triangulation stations as greatly to diminish the value of the triangulation for its primary purpose as a framework for future surveys. During the year, therefore, new triangulation extending from Point Arena to stations south of Monterey Bay was done, which serves to restore the value of the old triangulation by determining the new positions of sixty-one of the old triangulation stations. The triangulation included the Farallon Lighthouse, twenty-two miles to the westward of the great fault accompanying the earthquake, and the stations Mocho and Mount Diablo, thirty-three miles to the eastward of the fault. The new triangulation serves to trace the permanent distortions and displacements of the earth's crust for many miles back from the fault in each direction, and to show that they follow certain regular laws. This is the most extensive and accurate determination by triangulation of the effects of an earthquake which has yet been made anywhere in the world. Appendix 3 of the report gives a full report of this investigation.

A report on the measurement of six primary bases with steel and invar tapes in 1906 is printed as Appendix 4. The invar (nickel steel) tapes have a coefficient of expansion about 1/28th that of steel tapes, hence it is much less difficult to keep the temperature errors within the required limit with invar tapes than with steel tapes. Invar tapes had not been used in the United States until 1906 in primary base measurements. The thorough tests of these tapes, made by using them on six bases in conjunction with the steel tapes formerly used, showed that measurements may be made more conveniently, accurately, and at smaller cost per mile than with the steel tapes, and that the invar tapes are sufficiently durable and stable for safe field use. This demonstration is believed to be a distinct step in advance in base measurement.

The steady progress in the magnetic survey of the United States, and accumulation of magnetic observational data, as mentioned in Appendix 5 of the report, should be of special interest to the surveyor and the navigator, as well as to those pursuing the study of the science of terrestrial magnetism. Throughout the year the measurements of the earth's magnetism were made at places distributed over a majority of the States and territories of the United States, and at numerous places at sea along the Atlantic and Pacific coasts of North and South America, and in Porto Rico and the Philippines. Important information was secured in the equatorial regions. Numerous "repeat" observations were made throughout the country in order to follow as closely as possible the secular change in the magnetic elements. Five magnetic observatories were maintained in continuous operation, and important seismological data were also obtained. The facilities of the observatories were afforded to all investigators who desired to make standardisation comparisons of their instruments, and in response to numerous requests information or observational data was furnished for practical application or for use in special investigations of terrestrial magnetism and allied phenomena.

Appendix No. 6, constituting the concluding portion of a manual of tides, treats of the flow of water, of river tides, tidal currents, permanent currents, annual inequality, lake tides, seiches, and miscellaneous tidal matters. Charts of co-current lines are given for the principal marginal waters along the Atlantic coast of the United States. The numbers upon these lines show the times of the maximum flood current. The dependence of the permanent ocean currents and the annual height inequality upon the prevailing winds is briefly pointed out. Seiches are shown to exist in harbours and other tongues of water, as well as in lakes, but their character is fundamentally different in some respects. The analyses of observations upon the tides of Lake Superior show that they follow closely the equilibrium theory, although the

[1] "Report of the Superintendent of the Coast and Geodetic Survey showing the Progress of the Work from July 1, 1906, to June 30, 1907." (Washington: Government Printing Office, 1907.)

range is only $1\frac{1}{2}$ inches at Duluth and one-third inch at Marquette.

In Appendix No. 7 is given a detailed description, with appropriate illustrations, of the long wire drag, a device for detecting erratic obstructions of small extent in navigable waters. The method of operating can be understood from the simple statement that the drag is a wire varying in length from 480 feet to 1400 feet, supported at suitable intervals, and maintained at any desired depth below the surface of the water. This drag is towed over any given area by launches, and in the area so searched no elevation of the bottom above the depth at which the wire is suspended can escape detection. Buoys floating at regular intervals along the drag indicate to observers in the launches when and where an obstruction is touched, and the spot so indicated is then accurately determined.

This method of sweeping has proved a sure means of detecting pinnacle rocks and similar erratic obstructions which heretofore have eluded the hydrographic surveyor, since it is almost impossible to discover them by lines of soundings with the lead. Only the navigator in whose hands rest many lives and much property can realise the relief from mental strain that comes from knowing that the water in which he is sailing is absolutely free from hidden dangers, or that every menace is charted. The device has proved very satisfactory under widely varying conditions, and marks a decided advance in marine surveying.

The report, or any one of the appendices, may be obtained by interested persons, free of charge, upon application to the superintendent of the Coast and Geodetic Survey, Washington, D.C., U.S.A.

## *THE MECHANICS OF THE INNER EAR.*

THE University of Missouri has recently issued a memoir by Prof. Max Meyer, in which an interesting, instructive, and suggestive attempt is made to explain the mechanism of the cochlea without having recourse to the application of the principle of sympathetic vibration, or rather without the assumption that there exists in the cochlea, in the form of the organ of Corti, a vast number of delicate structures tuned, as it were, to tones of different frequencies. Prof. Max Meyer does not base his views on experimental data; his paper is a purely theoretical discussion as to how the cochlea may act, if we make six fundamental assumptions, none of which can, at present at all events, be tested by direct examination or by direct experiment. His inquiry begins with the movements, in and out, of the stapes at the oval window. The tube filled with fluid is divided into three compartments, the upper, the scala vestibuli, communicating at the apex of the cochlea with the scala tympani, at the foot of which we find the round window, while between the two scalæ we have the cochlear duct, or scala intermedia, composed, in its turn, on one side by the basilar membrane, on which rests the organ of Corti, and on the other by Reissner's membrane. When the base of the stapes is pushed inwards at the base of the scala vestibuli, pressure is communicated to the fluid in the scalæ (the scalæ communicating at the apex of the cochlea by a little opening, the helicotrema), and the membrane of the round window passes outwards, towards the tympanic cavity. It is generally held that with such pressure the fluid in the scalæ moves as a whole, and that pressure is communicated to the whole length of the scala intermedia, and especially to the basilar membrane, and that in this way the nerve-endings in Corti's organ are also submitted to pressure. The question then arises, is there any differentiating mechanism in the basilar membrane or in Corti's organ for tones of different frequencies, or, in other words, have we here an organ capable of analysis? Some deny any such property, while others, since the views of Helmholtz were first promulgated, are of opinion that there does exist an analysing mechanism.

The theory of Prof. Meyer essentially is that when the base of the stapes is pressed inwards a section of the membrana basilaris is also pressed in one direction until it reaches its limit of movement. On the basilar membrane rests the organ of Corti, the delicate hair cells being supported on the backs of the rods or arches of Corti. The membrane of Reissner may be regarded as merely protective, and a similar function Prof. Meyer awards to the arches of Corti, which are a kind of skeleton to prevent the delicate hair cells and nerve endings from being crushed by downward pressure on the membrana basilaris. No one can say what is the function of the membrana tectoria, the cushion-like structure that lies over the apices of the hair cells, and the nerve endings that, according to some histologists, lie between the hair cells. It may be a damper or it may be the arrangement by which pressures are made on the apices of the hair cells or nerve endings. There is thus, according to Prof. Meyer, a movement in one direction of a segment of the membrana basilaris, the direction being towards the scala tympani. When the base of the stapes has passed inwards to its fullest extent, the segment also moves to its limit, and then when the base of the stapes passes outwards the segment passes in the reverse direction, that is, towards the scala vestibuli. The rest of the basilar membrane beyond the segment is undisturbed. It is not known whether the basilar membrane is elastic or not; most probably it is non-elastic, but its backward swing has also its limits, and the velocity of the backward spring is probably slower than its forward swing, seeing that it is weighted on one side by the Corti cells, &c. The intensity of the tone will be determined by the amplitude of movement of the base of the stapes—the extent of the segment being greater as the amplitude is greater, and the reverse. Assuming that the number of nerve fibres in each segment is the same (which is unlikely), the greater the extent of the segment the greater will be the number of nerve fibres irritated, and the greater will be the intensity. The pitch will, of course, depend on the frequency of the movement of the segment, and there is no necessity for the assumption that either segments of the membrana basilaris, or structures upon these, are tuned to certain frequencies. When a compound tone or sound, say a fifth (the frequencies of the components of which are in the ratio of 3 : 2), is sounded, the base of the stapes makes a more complicated movement than that of a simple pendular vibration, and then this compound movement is resolved by two segments of the basilar membrane moving synchronously, in the ratio of 3 : 2, and the nerve endings in one segment would be irritated thrice during the time that the nerve endings in the other segment would be irritated twice. Still more, a segment at or near the base of the stapes would move once in the same time, and give rise to the differential tone, and so on.

Prof. Meyer thus recognises the cochlea as an analytic apparatus, without the necessity of any tuned mechanisms, and he works out his theory with great clearness, much ingenuity, and perfect fairness. His explanations of differential tones are in perfect consistence with his theory, and they are graphically delineated. He does not pretend that his theory is an ultimate solution of the problem attacked. Data are still wanting to found a final theory, and when we consider the minute size of the parts involved, it will probably be many a day before these data have been collected. But as experimental, and even observational, research must start from theory, however imperfect, Prof. Meyer has done good service in advancing his views.

The writer would only remark that he finds it easier to conceive the existence in the cochlea of arrangements adapted to frequencies, and consequently of an analysis by resonance, than to think of the membrana basilaris, short as it is, moving in segments when a complex mass of tones is objectively produced. Such a cochlea as Prof. Meyer has conceived might work in the way he thinks, and the writer would suggest that he should make a huge model, with a big piston, and ascertain whether a stout leather non-elastic membrana behaves as he expects it to do. The writer thinks that Helmholtz's resonance theory, with slight modifications, still holds the field, nor does it seem to him to be negatived (and the same remark applies to the theory of Prof. Meyer) even by the difficulties created by a consideration of differences of phase. The physiological effect produced by the relative *intensity* of a com-

[1] "An Introduction to the Mechanics of the Inner Ear." By Prof. Max Meyer. Science Series of the University of Missouri Studies. Pp. 140. (1907.) Price 1 dollar.

ponent of wave forms produced by components combined in different phases may enable us to distinguish one wave form from another, although, as has been proved experimentally, the forms must be different.

John G. McKendrick.

## COLOUR PHOTOGRAPHY.

The second annual exhibition of the Society of Colour Photographers will be open at 24 Wellington Street, Strand, until June 27. It includes about 230 examples prepared by the various methods that are now available. The section of transparencies on Lumière's autochrome plates is the largest; there are a few reproductions of autochromes, some pinatype transparencies, transparencies by the Sanger-Shepherd process, a good show of three-colour prints prepared with the Rotary Company's tissues and with the Autotype Company's tissues, some pinatype three-colour prints, and a few miscellaneous examples. It is clear that all these methods can be made to give good results, but in every section there is evidence that success cannot be expected without skill and practice.

There are no transparencies that surpass, if any equal, the examples of the Sanger-Shepherd process exhibited by Messrs. Sanger-Shepherd and Co., but we are glad to see some excellent autochromes, such as Nos. 108, 113, and 114 by Mr. J. C. Warburg, and No. 89 by Mr. Maurice Meys, as autochrome plates present the simplest method yet known for getting colour results. Many of the autochromes have an unpleasant coloured granulation obvious to anyone of keen vision when the plate is held at the normal distance from the eye. This is doubtless due to the grouping together into patches of the similarly coloured starch grains, and its absence in some examples may justify the hope that the makers can more thoroughly mix the differently coloured grains now than heretofore.

The application of autochrome plates to photomicrography is well exemplified by Drs. O. Rosenheim and H. R. Hurry. These gentlemen also show photomicrographs of the starch grain itself, and the area of the black filling between the coloured grains is larger than one would have expected, probably larger in the particular plate photographed than in many other plates. Mr. Welborne Piper's copies of autochromes on autochrome plates are very interesting as showing the result of attempts to multiply these colour photographs by exposure in the camera and also by superposition. It is clearly possible to use an autochrome that has not been reversed in the making as a negative from which to prepare other autochromes. Of the prints on paper, those by Mr. H. J. Comley, the secretary of the society, and by the Rotary Photographic Company are specially good, the latter showing excellent portraits of the German Emperor ar Empress and of Prof. Ostwald.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Lord Rayleigh will visit Cambridge on Tuesday, Wednesday, and Thursday, June 16, 17, and 18, in order to be installed as Chancellor. At 4 o'clock on Tuesday, June 16, he will open the new extension of the Cavendish Laboratory. On Wednesday, June 17, the Chancellor will hold a levée of members of the Senate in the Fitzwilliam Museum at 11.30. On the same day there will be a Congregation at 3.15 p.m., at which honorary degrees will be conferred. The Chancellor will visit the colleges on the morning of Thursday, June 18, and will be received at the gate of each college at times which will be notified.

Mr. A. C. Pigou, King's College, has been elected professor of political economy in succession to Mr. Alfred Marshall, who has resigned the chair.

Dr. Hobson has been re-appointed as Stokes lecturer in mathematics, and Dr. Baker as Cayley lecturer in mathematics, each for five years from Michaelmas, 1908.

The Bradford City Council has resolved to extend the technical college at a cost of 19,000*l.*, including equipment and machinery.

A course of three lectures on "Plankton" will be given by Dr. G. Herbert Fowler at University College on June 10, 15, and 23 at 5 p.m. The lectures are to be addressed to advanced students of the University of London and to others interested in zoology; they will be open to the public without fee or ticket.

Mr. R. N. Rudmose Brown has been appointed to the newly instituted lectureship in geography in the University of Sheffield. Mr. Brown accompanied the Scottish Antarctic Expedition in 1902 as naturalist to the expedition. He acted in 1906 as Special Commissioner, under the Indian Government, for the investigation of the pearl oyster fisheries of the Mergui Archipelago.

The International Congress of Historical Science is to be held in Berlin on August 6–12. The work of the congress will be carried on in general and sectional meetings. Among the eight sections are sections on Oriental history; history of Greece and Rome; history of civilisation and the history of thought, mediæval and modern; sciences subsidiary to history (archives, libraries, chronology, diplomatic, epigraphy, genealogy, historical geography, heraldry, numismatics, palæography, study of seals). Copies of the programme can be obtained from the secretary of the congress, Dr. Caspar, Kaiser-Allee 17, Berlin W. 15.

A combined examination for twenty-three medical entrance scholarships and exhibitions of an aggregate total value of about 1500*l.*, tenable in the faculties of medical sciences of University College, King's College, and in the medical schools of King's College Hospital, St. George's Hospital, Westminster Hospital, and the London School of Medicine for Women, will be held in London by the London Inter-collegiate Scholarships' Board on September 22 and following days. Full particulars and entry forms may be obtained on application to the secretary of the board, Mr. Alfred E. G. Attoe, University College, Gower Street, London, W.C., or to the deans or secretaries of the medical schools concerned.

The establishment of the proposed university for Bristol and the west of England, to which frequent reference has been made in these columns, will make desirable a scheme of cooperation between the Bristol University College and the Merchant Venturers' Technical College. The Society of Merchant Venturers has had the matter under consideration from time to time, and the proposals of the society, signed by its treasurer, have been printed and circulated. The technical college is carried on in three departments, viz. a secondary school, adult day classes for the study of the higher branches of applied science and technology, and evening classes in technological and commercial subjects for artisans. Only a part of the work is of university standard, and such part the society proposes to submit to the control of the new university, but to continue as before the remaining larger part of the teaching not of university standard. The society has expressed its willingness to undertake the faculty of applied science and engineering in the proposed university, and to hand over this work to academic control, a scheme the society maintains would prevent friction and overlapping. These proposals differ in essential respects from those of the university committee, which appears to have thrown out the suggestion that the society's secondary school should be discontinued in connection with the technical college; that the college buildings in Unity Street should be transferred to the University and used only for applied science and engineering, and that another school of technology under a composite committee should be established. To provide a new site and new secondary school—as was done in the similar case of University College, London—would cost, it is said, some 28,000*l.*, and the money does not seem to be forthcoming. The other suggestions of the university committee fail at present to meet with the approval of the society, but we are hopeful that when the money necessary for the establishment of a new university is available it will prove possible by mutual concessions to develop a plan which, while utilising all work of university standing at present being done, will in no way interfere with other good educational work being accomplished in the city.

## SOCIETIES AND ACADEMIES.

### London.

Royal Society, January 16.—"On the Perception of the Direction of Sound." By Prof. C. S. **Myers** and Prof. H. A. **Wilson**, F.R.S.

Lord Rayleigh (*Phil. Mag.*, 1907, xiii., 214) has shown that the determination of the apparent direction of a sound is influenced by phase-differences between the vibrations at the two ears. In the present paper this influence is experimentally further investigated, and a theory is advanced which offers a possible explanation of the effects ultimately in terms other than phase-difference.

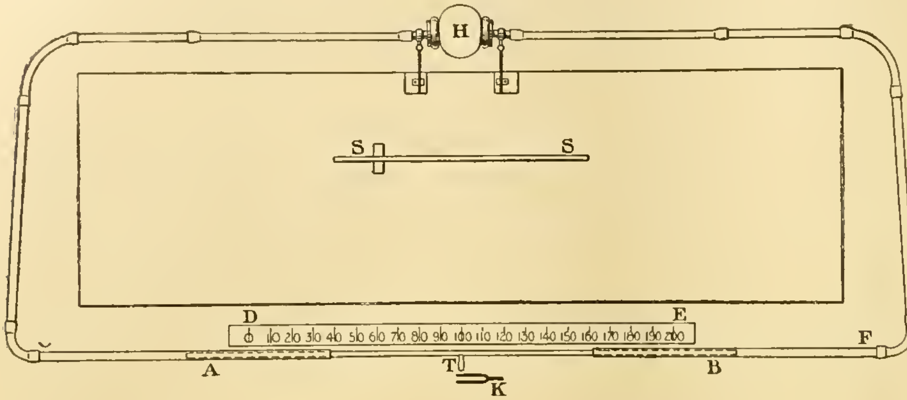


Fig. 1.

The apparatus (Fig. 1) used in these experiments consisted of a brass tube AB about 2·5 m. long and 2·5 cm. in diameter, at the centre of which a short T-piece T was soldered. This tube was freely movable within the two slightly larger tubes CD and EF, from the ends of which tubes were led to two softly padded caps, supported on retort stands, and applied to the ears of the observer H. Beside the tube AB was placed a graduated scale DE, which recorded the position of the T-piece. The sound entered the T-piece from a vibrating tuning-fork K held near it. By sliding the tube AB, so that the T-piece at different times pointed to different divisions of the scale, every kind of phase-difference between the vibrations reaching the two ears could be produced. A screen SS concealed the position of the T-piece from the observer.

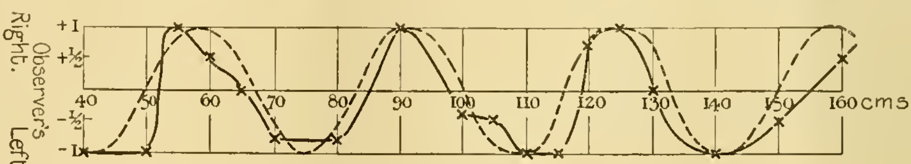


Fig. 2. (512)
(Observer facing towards fork)

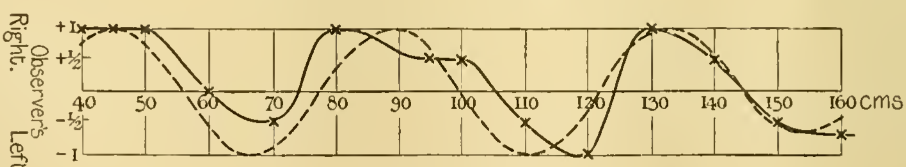


Fig. 3. (384)
(Facing towards)

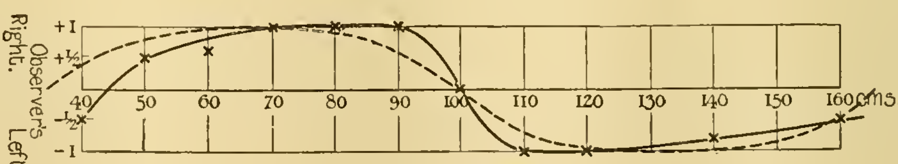


Fig. 4. (128)
(Facing towards)

One of the authors varied the position of the T-piece, sounding the tuning-fork before it at each position, while the other, acting as the observer, stated on which side the fork appeared to be sounding. The answers of the observer could be graded—"full right," "half right," "middle or half right," "middle," "middle or half left," "half left," "full left." At "half right" the lateral direction of the sound was only moderately clear; at "middle" or "half right" it was doubtful, while at "middle" there was no lateral effect at all.

If we call the lateral effect $\phi$, considering right effects positive and left effects negative, then, according to Lord Rayleigh's results, $\phi = A \sin(4\pi nx/v)$, where A is constant, $x$ is the distance in cm. of the T-piece from the middle point of the scale, $n$ is the number of vibrations per second, and $v$ the velocity of sound.

The results of the observations can be conveniently expressed in the form of curves, the abscissæ expressing the scale-readings and the ordinates the lateral effects. For this purpose a "full right" is reckoned as 1, a "half right" as a $\frac{1}{2}$, a "middle or half right" as a $\frac{1}{4}$, a "middle" as 0, the corresponding left effects having equal, but negative, values. Figs. 2, 3, 4 show the curves obtained with forks of frequencies 512, 384, 128. The dotted line in each figure is the curve $\phi = \sin(4\pi nx/v)$.

It is at once apparent that the theoretically and the experimentally obtained curves agree with one another remarkably well. The discrepancies which were sometimes met with were, with the aid of manometric flames, traced to the occurrence of resonance in one or other side of the tube. Interesting results were obtained from experiments conducted when the tubes were partially blocked or gradually pinched on one side. Other observations, of psychological rather than physical or physiological interest, are reserved for a future communication.

It is here suggested that the lateral effects thus produced by differences of phase at the two ears are really and ultimately due to the binaural differences of sound-intensity which must result, if the sound, entering one ear, is transmitted (as from psychophysiological data we know that it must be) across the head by bone conduction to the opposite ear. This suggestion receives support from a detailed mathematical consideration of the conditions. It may be added that the writers hope in a future paper to discuss the applicability of this explanation to the interesting experiments which Lord Rayleigh has brought forward.

March 5.—"The Relation between Wind Velocity at 1000 Metres Altitude and the Surface Pressure Distribution." By E. **Gold**. Communicated by Dr. W. N. Shaw, F.R.S.

It is a matter of common observation that the wind does not blow along the pressure gradient, but in well-exposed situations more nearly at right angles to it or along the isobars. It is equally well known that near the centres of anticyclonic or high-pressure areas the winds are very light, and it has been customary to attribute this fact to the coincident occurrence of small gradients of pressure. It appears, however, that these latter results, instead of being mutually explanatory, are both due to the effective centrifugal force arising from the earth's rotation, the admitted cause of the tendency to motion along the isobars.

If we express the fact that for steady horizontal motion in a path of curvature $1/r$, the part of the centrifugal force arising from the motion of the wind is balanced by the effective gradient of pressure, we obtain the equation

$$\frac{(wr\sin\lambda \pm v)^2}{r} = \frac{1}{\rho}\frac{\partial p}{\partial r} + \frac{(wr\sin\lambda)^2}{r},$$

where $p$ is atmospheric pressure, $\rho$ density, $v$ velocity of moving air, $\lambda$ latitude, and $w$ the angular velocity of the earth about its axis. If there is no friction, the variation of $p$ along the path must be zero or the path must be an isobar. If $\partial p/\partial r$ be negative, corresponding to a path concave towards the higher pressure, $v$ and $wr\sin\lambda$ must have opposite signs, or the air must rotate in a clockwise direction. Further, in this case $\frac{1}{\rho}\frac{\partial p}{\partial r}$ cannot exceed $\frac{(wr\sin\lambda)^2}{r}$ numerically, and $v$ cannot exceed $wr\sin\lambda$, so that for steady motion in anticyclonic regions there are definite limits to the gradient and velocity.

A general idea of the importance of this result is to be gained from the fact that at no point within 100 miles of the centre of an anticyclonic system of circular isobars in latitude 50° can the theoretical steady wind velocity exceed twenty miles per hour.

It is shown by analogy with the motion of a particle on the earth's surface that the time necessary for bringing about the state of steady motion is small enough for us to expect it to be the general state except where obstacles set up eddies. It is proved that the velocity calculated from the above equation is, for a given surface-pressure distribution, independent of the altitude provided there is no horizontal temperature gradient and the necessary corrections are given for the case of varying temperature when the direction of the horizontal isotherms does not change with altitude. The values of the theoretical steady velocity can by this means be calculated for any altitude from the surface observations. This was done for Berlin for 8 a.m. on each day of the year 1905, the temperature correction being disregarded. The results were compared with the actual velocities observed at 1000 metres' altitude in kite and balloon ascents. The theoretical and observed values showed a striking agreement both in direction and in magnitude, proving that the effect of surface irregularities on the horizontal air motion is practically obliterated at 1000 metres, and that we can obtain definite values for the wind velocity at moderate altitudes from the surface observations of pressure and temperature with a good degree of accuracy.

April 2.—"The Alcoholic Ferment of Yeast-juice. Part iii. The Function of Phosphates in the Fermentation of Glucose by Yeast-juice." By A. **Harden** and W. J. **Young**. Communicated by C. J. Martin, F.R.S.

(1) The addition of a phosphate to a fermenting mixture of glucose and yeast-juice not only produces a temporary acceleration in the rate of fermentation, but, in addition to this, an increased total fermentation.

(2) This last effect is due to the fact that the hexosephosphate formed during the period of temporary acceleration is continually hydrolysed by an enzyme, with production of free phosphate, which again enters into reaction, and thus brings about an increased fermentation.

(3) It appears probable that the presence of phosphate is essential for the alcoholic fermentation of glucose by yeast-juice, the reaction which occurs being the following:—

$$(1)\ 2C_6H_{12}O_6 + 2R_2HPO_4 = 2CO_2 + 2C_2H_6O + C_6H_{10}O_4(PO_4R_2)_2 + 2H_2O.$$

This reaction is only realised in the presence of the ferment and coferment discussed in previous communications, phosphate alone being unable, in the absence of coferment, to bring about fermentation in a mixture of ferment and glucose.

The hexosephosphate thus formed is then hydrolysed:—

$$(2)\ C_6H_{10}O_4(PO_4R_2)_2 + 2H_2O = C_6H_{12}O_6 + 2R_2HPO_4.$$

The rate at which this second reaction occurs determines the rate of fermentation observed when glucose is fermented by yeast-juice.

(4) An optimum concentration of phosphate exists which produces a maximum initial rate of fermentation. Increase of concentration beyond this optimum diminishes the rate of fermentation.

**Entomological Society**, May 6.—Mr. C. O. Waterhouse, president, in the chair.—*Exhibits*.—A. H. **Jones**: An example of the melanic ab. *nigra* of *Tephrosia consonaria* bred from the ovum from a wild ♀ taken near Maidstone, and a living larva of *Sesia andreniformis* feeding in the stem of *Viburnum lantana*.—R. **Shelford**: Specimens of insects in amber showing several forms closely allied to those of existing insects, one orthopteron being very near to *Ectobia lapponica*.—**President**: A living example of Blatta found in bananas from Mexico. Mr. Shelford said he thought the species to be *Pandora niveus*, Lin.—H. M. **Edelsten**: A living larva of *Nudaria senex*, and living larva and pupa of *Calligenia miniata*.—O. E. **Janson**: A white aberration of *Epinephele jurtina*, taken in Holme Park, Sussex, in June, 1904.—Lieut.-Colonel N. **Manders**: A collection of butterflies from Bourbon demonstrating examples of mimicry and the effects of the interaction of species.—W. J. **Lucas**: (1) A glow-worm found at Oxshott on May 4, inside the shell of the snail *Helix cantiana*. There was no doubt that the larva was feeding on the snail, for on breaking away parts of the shell the moist remains of it were found near the apex. (2) The ♂, ♀, and nymph of the dragon-fly *Oxygastra curtisii*, first described by the late J. C. Dale, and at that time supposed to be confined to the British Islands.—H. St. J. **Donisthorpe**: An example of the beetle *Xantholinus distans*, Kr., taken at Helton, near Dumfries, on May 1, a species new to the British list.—*Papers*.—The British dragon-flies of the "Dale collection": W. J. **Lucas**.—The distinctness of several species of Everes, determined by their genitalia: Dr. T. A. **Chapman**. The author announced as the result of his investigations that *Everes argiades*, Pall., and the so-called var. *coretas*, were separate, though very nearly allied species.

**Geological Society**, May 6.—Prof. W. J. Sollas, F.R.S., president, in the chair.—Solution valleys in the Glyme area of Oxfordshire: Rev. E. C. **Spicer**. This area is part of the gently tilted great oolite limestone plateau, indented by sunken valleys, principally with a strike-and-dip trend, that appear to be subsidence valleys. They begin suddenly, and descend with sinuous curves to a main valley. The main valley likewise enters a stream valley. The stream valley develops into a broad, sinuous river valley, over which a small river stream meanders. The plateau area is free from drift and from marks of surface denudation; there are no marks of marine currents or of ice, no wind-gaps suggest beheaded streams, nor is there evidence of vanished heights. At the mouths of the dry valleys issue streams impregnated with carbonate of lime. It is suggested that percolating water, forming an underground course along joint-lines, removes enough material in solution to weaken a long, winding area over which the surface subsides. Solution widens the stream banks into bowls of soakage, and leaves insoluble material to build up a level valley floor, which rises above and obscures the valley outlet streams, these then forming marshes.—The stratigraphy and structure of the Tarnthal mass (Tyrol): Dr. A. P. **Young**; with a note on two cephalopods collected on the Tarnthal Köpfe (Tyrol): G. C. **Crick.** The occasion for this paper is the discovery of fossils which appear to throw new light on the relations of the rocks of this mountain. The rock series is divided into three parts, and the succession summarised. An explanation of the structure is then suggested. A petrographical note is furnished on the amphibolite of Gufidaun.

**Physical Society**, May 8.—Dr. C. Chree, F.R.S., president, in the chair.—A modified theory of gravitation: Dr. C. V. **Burton.** If we are to regard gravitational attraction as exerted through the medium of the æther, it appears to the author difficult to avoid the conclusion that the very great (or possibly infinite) velocity with which such attractions are propagated is due to the very great (or complete) incompressibility of the æther. This conception is embodied in the pulsatory theories of Hicks and of subsequent writers; the chief outstanding difficulty has lain in providing for that agreement of phase which must be assumed to subsist amongst the centres of pulsatory disturbance associated with the mutually attracting masses. This difficulty is avoided if we suppose that primary waves of compressional-rarefactional type are being propagated through the æther with a velocity enormously transcending that of light. These primary waves may be travelling in directions indifferently distributed, or predominantly or exclusively in one direction; but an essential point is that all effective wave-lengths should be very great, measured even by astronomical standards. Thus the pressure changes will be sensibly in the same phase over considerable regions, and if the ætherial compressibility is locally increased (or diminished) by the presence of electrically neutral matter, every particle of such matter will act as a centre of pulsatory motion. For the electron, so far as concerns this modification of ætherial compressibility, a specification is assumed which involves no restraint on the free mobility of the electron through the æther. Incidentally, the dynamics of the problem assumes a relatively simple form, and a value which could be quite insignificant attaches to a "gravitational (or non-electromagnetic) term" appearing in the expression for the total inertia of an electron.—An examination of the formulæ for the grading of cables: C. S. **Whitehead.**—Illustrations of geometrical optics: R. M. **Archer.** Light from a narrow rectilinear source is allowed to pass through a slit and fall upon a flat white surface at almost grazing incidence. It is easy to obtain upon the surface a long narrow streak of light with sharp edges, and if a mirror be placed with its plane approximately normal to the surface another streak corresponding to the reflected ray can be seen. Similarly, the path of the beam after its emergence from a glass block or prism may be traced. Interesting effects can be obtained by using many slits and casting the beam from a distant optical lantern upon them. This mode of illumination is useful in demonstrating the formation of caustics. Quantitative results can be obtained comparable in accuracy with those given by an ordinary optical bench.

**Zoological Society**, May 19.—Dr. F. DuCane Godman, F.R.S., vice-president, in the chair.—*Exhibits.*—Preparations of a new gland found in certain teleostean fishes: W. **Woodland.** This new gland is quite distinct from the gas-gland, and consists of rows of huge columnar cells, which are situated in close connection with the blood-vessels, which possess large nuclei and nucleoli, and are packed with numerous large spherical granules derived from the red-corpuscle disintegration concerned in the generation of the oxygen contained in the swim-bladder. These granules, thus abstracted by the gland-cells from the blood, are carried away by special ducts appertaining to the gland. The discovery of this gland confirms Jæger's view as to the mode of generation of the bladder oxygen. This gland exists in Gobius, Syngnathus, Peristedion, Box, and some other genera.—Specimen of a petrel, *Œstrelata neglecta*, Schleg., picked up dead, yet in a quite fresh condition, at Tarporley, in Cheshire, on April 1, 1908: T. A. **Coward.** This bird is a native of the southern Pacific, and has almost certainly never been recorded from the northern hemisphere, and certainly never from Europe before.—The tanned skin of a wild cat, obtained by the Hon. Mason Mitchell, of the American Consular Service, in Sze-chuen: R. **Lydekker.** Mr. Lydekker had compared the skin with a light-coloured skin of *Felis temmincki* from Sikkim, and described it as a new local race of that species.—Specimen of chert from the Middle Culm-measures (Carboniferous) of Christon Down, near Doddiscombe Leigh, Devonshire, showing numerous large and well-preserved Radiolaria: C. Davies **Sherborn.**—*Papers.*—The Cyril Crossland collection of Calcarea from Zanzibar and Wasin (British East Africa): C. F. **Jenkin.** Notes on the Australian fossorial wasps of the family Sphegidæ, with descriptions of new species: R. E. **Turner.** Eighty species were described as new, and the absence of the genera Oxybelus and Philanthus, otherwise of world-wide range, from Australia was commented on. —The heredity of secondary sexual characters in relation to hormones; a contribution to the theory of heredity: J. T. **Cunningham.** The paper contained an examination and criticism of the most important recent investigations and theories on the subject by evolutionists of various schools, namely, the theory which attributes such characters to constitutional causes, such as male katabolism, Prof. Karl Pearson's biometrical investigation of sexual selection in man, Castle's Mendelian theory of the heredity of sex, and Geoffrey Smith's views on dimorphism of males and parasitic castration in Crustacea. The author maintained that all these contributions were more or less inconsistent with the known facts concerning the connection between the development of secondary sexual characters and the functional activity of the primary gonads. He directed attention to the recent discovery and experimental proof on the part of physiologists that the development of the characters was due to the stimulus of a chemical substance or hormone produced by the testis or ovary, and passed into the blood, and suggested that conversely hormones from parts of the soma might affect the gametes in the gonads. In this way the hypertrophy of a part of the body due to external stimulation might modify the corresponding determinants in the gametes so as to produce some hereditary effect in succeeding generations. Mr. Cunningham added that his theory was an interpretation in terms of modern physiology of Darwin's theory of pangenesis.

**Chemical Society**, May 21.—Sir William Ramsay, K.C.B., F.R.S., president, in the chair.—Hydro-aromatic ketones, preliminary note: A. W. **Crossley** and C. **Gilling.** A description of the condensation products obtained from 5-chloro-1 : 1-dimethyl-$\Delta^4$-*cyclo*hexenone-3, with ketonic esters.—The sulphides and oxysulphides of silicon: I. G. **Rankin** and S. M. **Revington.** Berzelius's sulphide is shown to be $SiS_2$, and the compositions of the monosulphide and the oxysulphides, SiSO and $SiSO_2$, have been definitely established.—Apparatus for experiments at high temperatures and pressures, and its application to the study of carbon: R. **Threlfall.** A simple and comparatively inexpensive steel apparatus for the investigation of reactions at high temperatures and pressures was described, and the results obtained by melting carbon under a pressure of about 100 tons per square inch were detailed. In every case soft, crystalline graphite was obtained, and the view is taken that for the formation of diamond under these conditions other substances must be present, and the nature of these will probably be determined by the constituents of diamond ash.—Acids as accelerators in the acetylation of amino-groups: Miss A. J. **Smith** and K. J. P. **Orton.** It was shown that minute quantities of sulphuric and other mineral acids greatly accelerate the acetylation of such substances as anilines with two negative groups in the ortho-positions with respect to the amino-group.—The chemical action of radium emanation, part iii., on water and certain gases: A. T. **Cameron** and Sir W. **Ramsay.** The decomposition of water and the re-combination of hydrogen and oxygen under the influence of radium emanation have been confirmed. Carbon dioxide decomposes into carbon, oxygen, and the monoxide, and the last is changed into carbon, oxygen, and the dioxide. Ammonia breaks up into its components, as does also hydrogen chloride. The rate of change in these reactions is in all cases proportional to the rate of change of the emanation.—The chemical action of radium emanation, part iv., on water: A. T. **Cameron** and Sir W. **Ramsay**. The formation of neon from radium emanation in presence of water is confirmed.—Titani-dihydroxymaleic acid, and the detection of titanium: H. J. H. **Fenton**. Dihydroxymaleic acid in aqueous solution gives an intense red-brown colour with quadrivalent titanium compounds. The reaction is sensitive enough to be used as a test for titanium, and serves to distinguish it from vanadium.—The preparation of diselenides. Dibenzyl diselenide, preliminary note: T. S. **Price** and L. M. **Jones**. The diselenides are prepared by the addition of a solution of sodium selenosulphate to a solution of the alkyl chloride.—The optical and sensitising properties of *iso*cyanine dyes: S. E. **Sheppard**. The results of an examination of the absorption spectra, &c., for gelatinobromide plates are given.—The polarimetric study of intramolecular re-arrangement in inactive substances: T. S. **Patterson** and A. **McMillan**. The authors have applied their method (Trans. Chem. Soc., 1907, xci., 504) to measure the rate of inversion of piperonal*syn*oxime and similar substances.—Mercuric zinc cyanide: W. R. **Dunstan**. The formula $Zn_3Hg(CN)_8$ is now given to this substance instead of $Zn_4Hg(CN)_{10}$, as formerly proposed (Trans. Chem. Soc., 1892, lxi., 666).—Ethyl 6-methyl-2-pyrone-3:5-dicarboxylate and its derivatives: J. L. **Simonsen**.—Contributions to the chemistry of the amidines, part ii., 2-anilinobenzoxazole and the supposed anilodihydrobenzoxazole: G. **Young** and A. E. **Dunstan**.—The slow decomposition of ammonium chromate, dichromate, and trichromate by heat: W. C. **Ball**. The dichromate evolves nitrogen, water, and ammonia, and leaves eventually a black compound, $3CrO_2,H_2O$. At an intermediate stage a black product having the formula $2CrO_3,Cr_2O_3,2NH_3,H_2O$ is formed.

**Royal Microscopical Society**, May 20.—Mr. A. N. Disney in the chair.—A series of lantern-slides of old microscopes that the society will exhibit at the Franco-British Exhibition was shown on the screen. Mr. **Rousselet**, the curator, in giving a description of the instruments, said the collection was illustrative of the history of the microscope, and would consist of twenty-eight microscopes mostly taken from the society's collection, several others being lent for the purpose by Sir Frank Crisp and Mr. E. M. Nelson. The collection included, with others, a model of Leeuwenhoek's microscope, date about 1673; microscopes by Musschenbroek, 1702; Wilson, 1702; Culpeper, before 1738; Lieberkuhn, 1738; John Marshall, 1744; John Cuff, 1744; Benjamin Martin, 1760, and one made for George III., 1771; Dellebarre, 1777; Jones's "Most Improved," 1798; Lister-Tulley, 1826; Cuthbert's reflecting microscope, 1827; Chévalier, 1834 and 1840; Hugh Powell, 1839 and 1841; Jas. Smith, 1841; Andrew Ross, 1842; Dr. Edwin Quekett, 1844; and Powell and Lealand, 1848.—An old photomicrographic apparatus designed by Dr. Maddox for Dr. Lionel S. Beale: J. E. **Barnard**. There were two points of interest about it, the first being the application of an arrangement between the objective and the stage for excluding extraneous light, the other was that the illuminating apparatus was carried on a triangular bar, which had the apex inverted, thus losing the advantage to be derived from the application of the principle of the triangular bar.

Cambridge.

**Philosophical Society**, May 4.—Dr. Hobson, president, in the chair.—The geographical distribution of the acarine family Oribatidæ: C. **Warburton**. It seemed likely that if ever the Oribatidæ of the world should be widely investigated they would prove to be a very characteristic fauna of the various zoological regions, for they seem to possess none of the facilities for extensive distribution exhibited by most of the other Arachnids or by insects. They are highly specialised mites, not parasitic on animals like the ticks and Sarcoptidæ, nor attaching themselves to other creatures for purposes of distribution like the Tyroglyphidæ. They are, of course, wingless, nor have they the power of spinning silken parachutes like spiders so as to utilise the wind. They are slow moving, vegetable-feeding mites, and in England their distribution is very local. Samples of moss containing the living mites have been received from certain widely separated localities, and the results are not at all what were expected. On the whole there is a great resemblance between all the collections, and some species seem to be practically cosmopolitan. Moreover, these species are not primitive in appearance, nor are they among the most active of the group. The almost world-wide distribution of certain forms seems difficult to account for unless the creatures have remained unaltered for a very long period of time.—Some new and obscure species of the genus Hæmaphysalis of the Ixodidæ: C. **Warburton**. This paper was an attempt to remove the confusion which had arisen with regard to the species *Haemaphysalis flava*, *H. bispinosa*, and *H. papuana*. Four species had been confused under the name of *H. flava*, and two of these were now described as new—*H. japonica* and *H. campanulata*. Neumann's *H. bispinosa* was restored and separated from *H. hystricis*, of which he considered it a synonym. A species confused by Neumann with *H. papuana* was described as new under the name of *H. crassa*.—The fauna of the Bradford coke bed effluent: Dr. A. **Meixner**.

Manchester.

**Literary and Philosophical Society**, April 7.—Mr. Francis Jones, vice-president, in the chair.—The occurrence of quartz crystals in limestone, columnar coal, marble, &c.: R. **Pettigrew**. Photographs, microscopic and lantern-slides, were exhibited showing microscopic crystals of quartz obtained from mountain limestone, columnar coal from Airdrie, in Lanarkshire, and ordinary statuary marble.—Note on the action of oxalic acid on cellulose: Prof. E. **Knecht**. It appears that the action of oxalic acid on cellulose simply constitutes one example of a general mode of formation of acidyl celluloses.

April 28.—Prof. H. B. Dixon, F.R.S., president, in the chair.—Some observations on the chemical effect of tropical sunlight: Dr. G. J. **Fowler**. The results show that the greatest photochemical effect is obtained on the sea, the highest record being on the Arabian Sea (lat. 16° 31′, long. 54° 8′) in the vicinity of the Arabian coast. Here the chemical intensity of the sunlight was forty-two times what has been recorded on a bright sunny day in winter in Manchester, and three times the highest summer record in Manchester. The average record for Calcutta was about double the highest for Manchester in 1892. There does not appear to be any relation between the photochemical effect of sunlight and the liability to cause sunstroke, the records in the Mediterranean being as high as in Calcutta, and one record furnished by Dr. Bailey from Pontresina being higher than the average for Calcutta. Evidence is also mentioned which suggests that sunstroke is not purely a heat effect. In the same way sunburn does not seem to depend entirely either on the photochemical or heat intensity of sunlight. The full explanation of these phenomena has not, it is believed, been yet given. The results of the observations recorded show generally that the photochemical effects of tropical sunlight do not differ in kind from those observed under European conditions; indeed, in certain favoured European localities equally striking effects may be obtained.

Paris.

**Academy of Sciences**, May 25.—M. H. Becquerel in the chair.—The recent eruption of Etna (Taormina, May 15, 1908): A. **Lacroix**. This eruption broke out in a region quite distinct from that of the eruptions of 1883, 1886, and 1892. Details are given of the formation and appearance of the new crater, of the lava, and the erosion phenomena caused by the lava.—The stimulating properties of the serum of healthy and tuberculous animals, and of animals treated with tuberculin, on cobra poison: A. **Calmette**, L. **Massol**, and C. **Guerin**. A description of experiments on the production of lecithin in blood serum by experimental tuberculosis.—A method of M. Goursat in Monge's problem: P. **Zervos.**—The general problem of probabilities in repeated trials: L. **Bachelier.**—The secondary rays from the $\alpha$ rays: William **Douane.** The production of the secondary rays ceases almost entirely when the radium salt is removed more than 2 cm. from the slit; this distance is precisely that which was found in earlier experiments for the charge of the $\alpha$ rays.—The potential difference and stability of the alternating arc between metals: C. E. **Guye** and A. **Bron.** The contradictory results of earlier workers are largely due to the difficulty of maintaining the stability of the arc. The authors have obtained arcs of high stability by bringing the electrodes to a temperature near their melting points, and having a large reserve of potential (20,000 volts) in open circuit. For metals which are slightly volatile the potential difference, under equal conditions, tends to a lower limit, approximately the same (about 470 volts) for all metals.—The existence and origin of harmonics in the self-induction spark: G. A. **Hemsalech.**—The impossibility of diagnosing death by the radiography of the abdominal organs: Maxime **Ménard.**—Contribution to the study of the oxidation phenomena produced by iodic and bromic acids: H. **Baubigny.** Bromide of silver in ammoniacal solution is stated to be converted at 100° by iodic acid into silver iodide and ammonium bromide; this statement is now shown to be erroneous, the reaction in reality being quite different. A small proportion of the ammonia is oxidised by the iodate at 200°, nitrogen, water, and ammonium iodide being produced.—A new volumetric method allowing the simultaneous estimation of carbonic acid and other acids in atmospheric air: H. **Henriet** and M. **Bouyssy.**—The estimation of tungstic acid and its separation from other substances by the use of a mixture of chlorine and chloride of sulphur: F. **Bourion.** The method proposed is described in detail, and its accuracy proved by the results of analyses of sodium tungstate, silicotungstic acid, ytterbium, silicotungstate, and a mixture of silica and tungstic acid.—The triboluminescence of mineral substances: Adrien **Karl.**—The syncytial nature of the intestine of Rhabdocœles: Paul **Hallez.**—The comparative action of simple salt solutions and artificial serums with complex mineral contents on the blood and circulation: C. **Fleig.**—The action of acids on the coagulation of milk by vegetable ferments: C. **Gerber.**—The experimental study of the cutting of twigs for slips: A. **Imbert.**—The study of the bactericidal action of anti-virulent serum on the adventitious germs of vaccine: L. **Camus.**—The transmission of syphilis to the cat: C. **Levaditi** and T. **Yamanouchi.**—The different levels of alluvium at the confluence of the Yonne and the Cure: Paul **Lemoine.**—Two causes of error in experiments on fluorescein: F. **Dienert.** A fluorescent substance occurs naturally in certain waters, and this may cause difficulty when fluorescein has been used to trace the passage of underground water. The added dye may often travel very slowly, and by its appearance cause confusion when a second experiment is being carried out in the same district.—The temperature of the thermal waters of the eastern Pyrenees: O. **Mengel.**

## DIARY OF SOCIETIES.

*THURSDAY*, JUNE 4.

ROYAL SOCIETY, at 4.30.—On the Aberration of Sloped Lenses and on their Adaptation to Telescopes of Unequal Magnifying Power in Perpendicular Directions: Lord Rayleigh, O.M., Pres. R.S.—The Optical Constants of Gypsum at Different Temperatures, and the Mitscherlich Experiment: Dr. A. E. H. Tutton, F.R.S.—On the Viscosity of Ice: R. M. Deeley.—The Effect of Temperature on the Neutralisation-Volume Change for Different Salts at Different Concentrations: Miss Ida Freund.—Note on a New Sounding Machine for Use on Lakes and Rivers without a Boat: Prof. E. J. Garwood.—The Electrical Qualities of Porcelain, with Special Reference to Dielectric Losses: H. F. Haworth.—On the Decay of the Radium Emanation when Dissolved in Water: R. B. Moore.

ROYAL INSTITUTION, at 3.—The Chemistry of Photography: Dr. Alexander Scott, F.R.S.

LINNEAN SOCIETY, at 8.—Note on the Spicules of *Chirodota geminifera*, Dendy and Hindle: Prof. A. Dendy, F.R.S.—Two New Fungus Diseases: E. S. Salmon.—The Caryophyllaceæ of Tibet: F. N. Williams.—Polychæta of the Indian Ocean: F. A. Potts.—The Stylasterina of the Indian Ocean: Dr. S. J. Hickson, F.R.S., and Miss Helen M. England.—A Contribution to the Mycology of South Africa: W. N. Cheesman and T. Gibbs.—*Exhibits*: Drawings prepared to illustrate Descourtilz's "Ornithologie brésilienne": C. E. Salmon.—Lantern-slides of the Life-history of a Wood-boring Wasp: F. Enock.

INSTITUTION OF MINING ENGINEERS, at 11 a.m.—Presidential Address by C. E. Rhodes.—The Mineral Resources of Trinidad: J. Cadman.—The Occurrence of Fluorspar in Derbyshire: C. B. Wedd and G. C. Drabble.—Calcining-kilns: G. Jones.—Cobalt and Northern Ontario: J. B. Tyrrell.

CHEMICAL SOCIETY, at 8.30.—Condensation Products from Pinene Aminodicarboxylic Acid: W. Godden.—A Delicate Test for Bromides alone, or in Solution with Chlorides: J. S. Jamieson.—Experiments on the Synthesis of 1-Methylcyclohexylidene-4-acetic Acid: W. H. Perkin and W. J. Pope.—The Triazo-group. Part iv., Allyl Azoimide: M. O. Forster and H. E. Fierz.

*FRIDAY*, JUNE 5.

ROYAL INSTITUTION, at 9.—The Nadir of Temperature and Allied Problems: Sir James Dewar, F.R.S.

INSTITUTION OF MINING ENGINEERS, at 11 a.m.—Winding-engine Tests, with Notes and Suggestions on the Design and Testing of Plant: S. L. Thacker.—The Utilisation of Sewage for the Production of Crude Oil and Ammonia: M. F. Purcell.—The Oil Prospects of Central British South Africa: Dr. C. Sandberg.—Oil-mining: D. M. Chambers.—Mining in the Boundary District of British Columbia: F. Keffer.

*TUESDAY*, JUNE 9.

FARADAY SOCIETY, at 8.—The Utilisation of Atmospheric Nitrogen in the Production of Calcium Cyanamide and its Use in Agriculture and Chemistry: Dr. R. A Frank.

*THURSDAY*, JUNE 11.

MATHEMATICAL SOCIETY, at 5.30.

*FRIDAY*, JUNE 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.

ARISTOTELIAN SOCIETY (at Cambridge).—Symposium: The Nature of Mental Activity: Profs. S. Alexander, James Ward, Carveth Read, and G. F. Stout.

PHYSICAL SOCIETY, at 8.—Experiments on a Directive System of Wireless Telegraphy: Messrs. Bellini and Tosi.—On the Lateral Vibration and Deflection of Clamped Directed Bars: Dr. Morrow.—On the Resistance of a Conductor of Uniform Thickness whose Breadth Suddenly Changes, and on the Shapes of the Stream-lines: Prof. Lees.—On the Self-inductance of Two Parallel Wires: Dr. Nicholson.—On Homogeneous Secondary Radiation: Dr. Barkla and Mr. Sadler.—Notes on the Motion of a Corpuscle and on Cloud Formation: Prof. Morton.

GEOLOGISTS' ASSOCIATION, at 8.—Origin of Mountain Tarns: Prof. E. J. Garwood.

## CONTENTS.

THURSDAY, JUNE 11, 1908.

## SYSTEMATIC EXPLORATION AT DEIR-EL-BAHARI.

*The Eleventh Dynasty Temple at Deir-el-Bahari.* Part i. By Eduard Naville, with chapters by H. R. Hall and E. R. Ayrton. Pp. ix+75; 31 plates. (London: The Egypt Exploration Fund, 1907.) Price 25*s*.

IN 1893, Prof. Naville undertook for the Egypt Exploration Fund the work of clearing Queen Hatshepsut's celebrated temple at Deir-el-Bahari at the foot of the cliffs bounding the western side of the necropolis of Thebes. This work was completed in 1903, but during the progress of the clearing certain relics of the eleventh dynasty were unearthed which led M. Naville to believe that under the sand and rubbish mounds on the south side of Hatshepsut's temple lay concealed a building or cemetery of the Early Middle Kingdom. In these southern mounds of Deir-el-Bahari, Prof. Naville and Mr. H. R. Hall began to excavate in 1903, and they soon brought to light the platform of what they conjectured to be another and an earlier temple. Continuing their excavations, they found a number of slabs of stone and columns bearing the cartouches of King Neb-hatep-ra Mentu-hetep, and it was not long before they had cleared enough of the building to show that the ruin before them must be the mortuary temple of that eleventh-dynasty King. The clearing was steadily continued during the winter seasons until 1907, and the volume before us is the first part of the record of a patient and thoroughly systematic piece of exploration. In the writing of the memoir Prof. Naville has been assisted by Mr. H. R. Hall, of the British Museum, and by Mr. E. R. Ayrton, one of the Egypt Exploration Fund officers.

In the first chapter Prof. Naville deals with the difficult question of the sequence of the eleventh-dynasty kings. The Royal Canon of Turin preserves the names of only the last two: (1) Neb-hatep-ra (Mentu-hetep) and (2) Se-ankh-ka-ra (Mentu-hetep) The order of three other kings of this dynasty is now established from a newly acquired stele in the British Museum quoted by M. Naville; this gives (1) Uah-ankh Antef-aa, (2) Nekht-neb-tep-nefer Antef, and (3) Se-ankh-ab-taui Mentu-hetep. The only other well-authenticated sovereign of this Theban line of princes is Neb-taui-ra Mentu-hetep, whose place is probably between Se-ankh-ab-taui Mentu-hetep and Neb-hatep-ra Mentu-hetep. To this list of six kings Prof. Naville would add another Mentu-hetep whom he calls Mentu-hetep III., but the separate existence of this sovereign is extremely problematical; he only differs in his "Horus" name from Neb-hatep-ra (M. Naville's Mentu-hetep II.), his prenomen and nomen are the same, and the difference in the Horus-name may well be due to his further territorial conquests. Another King Mentu-hetep discovered by M. Naville (pl. xii. i) certainly belongs to the later intermediate period between the end of the twelfth dynasty and the beginning of the eighteenth; the prenomen cannot be read on the published fragment Se-kha-en-ra as the explorer suggests, although that prenomen certainly occurs on another block found in the temple (pl. xii. j). Se-kha-en-ra, it may be pointed out, is the prenomen of a Hyksos king, and to the Hyksos period or thereabouts also belong the vassal Kings Dudu-mes (p. 3) and Senb-ma-iu (Naville in E.E.F., Arch. Report, 1906–7, p. 6), monuments of whom M. Naville and Mr. Hall have found in the eleventh-dynasty temple at Deir-el-Bahari.

In the second chapter Mr. Hall deals with the temple and its excavation. He points out that although the mortuary temple of Neb-hatep-ra has been found, the actual *tomb* of the king, which we know from the Abbott Papyrus was intact as late as the time of Rameses IX., has as yet eluded the explorers' search. The name of the temple was Akh-asût-Neb-hatep-ra, "Brilliant are the seats of Neb-hatep-ra," and it is often mentioned in the hieroglyphic inscriptions. The second mortuary temple, named Men-asût, "Firm are the seats," referred to on p. 11, was that of Queen Ahmes-nefret-ari, and was discovered in 1896 on the edge of the desert at Kurneh—a fact which seems to have escaped Mr. Hall's notice. Dating from the beginning of the Middle Empire, this temple discovered by the officers of the Egypt Exploration Fund is the earliest Theban temple known to us, and it is consequently of great interest. It seems to have been the prototype of Hatshepsut's temple, for, like it, it is constructed in terraces, the approaches to which are a ramp or inclined plane flanked by colonnades of square pillars having the cartouche of the king. The ramp leads to a platform which supported the front part of the temple, while the rear portion was cut out of the living rock. In the middle of the upper court is a large superstructure of rough stones which bore a small pyramid—a mere architectural erection—about sixty feet square at the base. This was surrounded by an ambulatory of octagonal sandstone columns, many of which still remain in position. The walls were covered with painted reliefs of religious and civil scenes, and at the back of the central superstructure were found remains of shrines of certain priestesses of Hathor under the eleventh dynasty. The painted reliefs discovered have a curious archaistic appearance. Some depict men gathering reeds, driving animals, sowing and reaping, and so forth, for the maintenance of the royal funerary cult. Others give scenes from the ceremonies of the Sed-festival, and show processions of priests and warriors. The most important, however, are those which relate to a campaign of Neb-hatep-ra against the *Aamu* (pls. xiv., xv.) and the *Reten-reru* (pl. xv. F), both peoples of Asia. The patron goddess of the temple was Hathor, and it is curious that Amon does not appear to find a place in the reliefs, although Set is represented on the wall of the western court in his traditional guise.

In the third and fourth chapters the authors describe very carefully the various tombs found during the course of the excavations: "they are all, with one possible exception, of the eleventh dynasty, and therefore contemporary with the temple," though certain of them contained secondary burials. The sarcophagi of the Princesses Kensit and Kauit will henceforth rank as important examples of the eleventh-dynasty workmanship.

The fifth chapter, by Prof. Naville, is devoted to the twelfth-dynasty monuments found in the temple area, and to the worship, in the later periods of Egyptian history, of King Neb-hatep-ra, the founder of the temple. The most important monument of the twelfth dynasty unearthed was a red granite stela of Senusret III. (why do the authors retain the obsolete transliteration Usertsen?) recording a royal decree to the priest of Amon and to the officials of Thebes, "ordering rations of bread, and beer over and above what had been given before, in order to increase the offerings of his forefather Neb-hatep-ra." This stela, more than one and a half metres high, has since been removed to the Cairo Museum.

In the last chapter, M. Naville deals with his discovery of the famous Hathor Shrine containing the Cow-statue, at present one of the chief objects of interest in the museum at Cairo. This splendid specimen of the Egyptian sculptor's work M. Naville believes dates from the reign of Thothmes III., but it bears the name of his son, Amenhetep II. A fine coloured reproduction of it is given in pl. i., from a water-colour drawing by Mr. Reach.

Several of the photographic plates are poorly reproduced, but a word of praise ought to be given to the line drawings of Madame Naville, which, as always, are excellent.

## BIOGRAPHY OF AN INVENTOR.

*Thomas Alva Edison: Sixty Years of an Inventor's Life.* By Francis Arthur Jones. Pp. xvi+375; with 22 illustrations. (London: Hodder and Stoughton, 1907.) Price 6s. net.

"IT is estimated," so Mr. Francis Arthur Jones tells us, "that if everything that has ever been written and published about Edison were collected and re-published in book form, it would make a library of a thousand volumes—each volume containing an average of a hundred thousand words." The present biography is a most readable and interesting book, which gives a very good insight into Edison's life in the space of 375 pages. It is written for the general rather than the scientific reader. It would be a capital book to place in the hands of schoolboys, and if juvenile readers were to play at setting up make-believe printing presses in railway trains in emulation of Edison's first attempts at educating himself the amusement would be a harmless and instructive one, if they did not reproduce the fiasco which first put the youthful inventor "down on his luck."

This biography should do much to disillusion the impressions which are so commonly formed about successful men, that they only have to invent something in order to make a fortune. It shows clearly that the only road to success is through failure. His career as telegraphic operator was most precarious, and one of his first inventions—a vote-recording machine for election purposes—was refused, really because it was too ingenious and perfect; in fact, it could not be tampered with. His resolve never to invent anything which was not wanted by the community at large helped him greatly, but still the telegraph companies would not seriously consider his systems of multiplex telegraphy until he had done something more. That something was to help them out of difficulties when a breakdown occurred. His successes in obtaining his first cheque from the Gold Indicator Company, and in securing the adoption of his improvements in telegraphy, were only achieved when he had shown his capacity of being handy man in an emergency. Then the success of his inventions in connection with the telephone and phonograph was only bought at the cost of long and patient attempts at trying first one substance and then another for the transmitter of the former and the cylinder of the latter. As to the continual litigation which fell on Edison's shoulders in order to protect his patents, Mr. F. A. Jones's information regarding the large staff of solicitors employed in Edison's legal department bears abundant testimony.

In the later chapters we see how even success brought troubles with it in the form of a crowd of reporters, interviewers, cranks and faddists, and it cannot be doubted that Edison's good humour and ready wit, of which we have here many amusing instances, no less than his indomitable energy and perseverance, were greatly needed in order to enable him to cope with all the work that fell on his shoulders. His biographer is also at considerable pains to disillusion the reader as to the wild and fantastic inventions attributed by unscrupulous newspaper reporters to "the wizard of Menlo Park," and to which the name "Munchausen science" has been given. Unfortunately, many of these tall stories have been read and widely believed in England, and no one is stronger in his condemnation of such fictions than Edison himself.

It would be very desirable that a further book should some day be published dealing more especially with the scientific aspect of Edison's work. It would undoubtedly be a difficult task to write such a book. If Edison did not study at a university in the accepted meaning of the term, he certainly appears to have made a university for himself in his workshops, in which he was his own professor, and it cannot be denied that the training he underwent under these conditions was fully as efficient, and in many ways better, than a course modelled on conventional lines. His education was undoubtedly thoroughly scientific in the best sense of the word, but it was different in the matter of technicalities from that of the ordinary science student. Consequently Edison nowhere figures as a contributor of papers in transactions and periodicals. Some evidence is given in this book that results published elsewhere as "researches" were well known to him years previously. His "notion books," couched though they be in a mysterious language of their own, must contain a lot of important new results, and it will be a pity if no steps are taken to render these results accessible to scientific workers at some future time, if not now. The statement that Edison is now devoting himself exclusively to pure science thus becomes welcome news.

The book is illustrated in the approved style with "Edison at the age of four," "Edison at nineteen," "Edison at forty," and so forth, also "Mr. and Mrs. Edison in the laboratory"; altogether more than a score of illustrations.

We think that one person is kept rather more in the background than is really necessary in this book, that person being Mr. Francis Arthur Jones. He shows such an intimate knowledge of and friendship with Mr. and Mrs. Edison that some further reference to his personal relations with them would not only be justifiable, but would give an added interest to the biography.

We must, however, direct attention to the statement on the last page:—

"Of the force hidden in coal about 15 per cent. only is available, the other 85 per cent. being wasted That is why it requires so many hundreds of tons o coal to propel a liner across the Atlantic. When the problem of generating electricity direct is solved, then two or three tons of coal only will be needed for the same purpose."

"Many hundreds of tons" is, of course, a somewhat elastic term, and we do not know whether Mr. Edison or Mr. Francis Arthur Jones is responsible for the above statement, but taking, say, five hundred tons by way of argument, it is surely a little unnecessary for either of those gentlemen to imperil his reputation for the sake of seventy-two tons of coal.

G. H. BRYAN.

## A FRENCH TREATISE ON GEOLOGY.

*Traité de Géologie. I. Les Phénomènes géologiques.* By É. Haug. Pp. 536; 195 figs., 71 plates. (Paris: Armand Colin, 1907.) Price 12.50 francs.

AMONG the most important of the perpetual needs of geology is the frequent renewal of the international supply of advanced text-books, from which the general conclusions of foreign authorities and the outlines of the geology of foreign lands may be learnt apart from the now overwhelming mass of original literature. In such books the interests of the local students, to whom illustrations of normal phenomena are most important, to some extent conflict with the requirements of foreign geologists, who will profit by the description of exceptional occurrences; but fortunately most authors of advanced works may be trusted to enliven their books by a sufficient number of special cases to make them useful to foreign geologists. The issue of an extensive treatise on geology by Prof. Émile Haug, of the University of Paris, is, therefore, to be warmly welcomed by British geologists, as we may expect it to give an instructive account of geological phenomena in France, a guide to the original literature, and a clear exposition of the current state of geological thought in that country.

Prof. Haug's first volume deals with geological processes and materials. In his statement of the relations of geology to allied sciences he lays stress on the essential importance in geology of the succession of phenomena; and this idea finds frequent expression in the book, from the first chapter on the geological cycle to the last on theories of orogenesis The volume opens with an account of the general morphology of the earth, and he says that "the geological history of our planet is nothing else than the history of its successive cycles"; and he regards the three main subdivisions of geological history, for which he uses the names Primary, Secondary and Tertiary, as each a great cycle beginning with very active sedimentation, followed by intense crustal movements, and closing with a period of great consequent denudation. He suggests that the "preprimary" was a similar cycle, and that the "post-tertiary" will be another."

In his description of rocks he follows the guidance of the same principle by describing them under the headings of lithogenesis, orogenesis, and glyptogenesis, *i.e.* their formation, modification, and destruction. He then proceeds to biological geology, discussing the life of the continents and the distribution of botanical and zoological provinces. The author attaches no value to the theory of the permanence of oceans and basins; and although he notices the objections of Koken and Frech to the assumed Pacific continent, he warmly maintains its former existence. According to Prof. Haug, there were five great continents in Secondary times—the North-Atlantic continent, the South Atlantic or Brazilio-African continent, the Sino-Siberian continent, the Austral-Indian-Madagascan continent, and the Pacific continent. He maintains the Mesozoic existence of these continents, and the fundamental difference from the present distribution of land and water, as a necessary consequence, both of the tectonic structure of the earth and of the distribution of animals and plants. He maintains that:—

"The enigmas of zoological geography are absolutely insoluble if one regards only the existing state of things. But as soon as one admits that the distribution of lands and seas was not, in geological epochs anterior to our own, the same as it is to-day, all these facts become clear in a new light."

After three chapters dealing with the sedimentary rocks, and one on mineral-fuels, the author discusses tectonic geology, crustal movements, and the phenomena of volcanoes and earthquakes. The chapter on fuels shows the author's thorough chemical knowledge of his subject. The excellent chapters on mountain structure are illustrated by numerous clear diagrams to explain the views and terms of Suess, and by artistic photographs of those French Alpine regions where the author has made important researches.

In the treatment of so wide a range of subjects there are naturally a few slips; thus the author four times refers to Ceratodus as living in Tasmania instead of Queensland, and he follows another important recent text-book in the statement that the New Zealand geysers were destroyed by the eruption of 1884. That eruption, however, though it destroyed the sinter terraces of Rotomahana, actually increased the activity of the New Zealand geysers, until they culminated in the eruptions of Waimangu, the greatest of known geysers. Some of the opinions expressed by the author may not be generally followed. He holds that the diamond-bearing block of nickel-iron found in the Diablo Canyon was of volcanic origin, and not a meteorite. According to him, the lateral secretion hypothesis "ne compte plus guère d'adeptes"; and he refers to the impregnation theory for the banket of the Rand as if it were universally accepted, although during recent years the majority of the Rand mining engineers who have had previous experience of placer deposits have rejected the theory.

Each chapter is followed by a bibliographic list, of which one striking feature is the rarity of reference to British geologists even when dealing with British rocks and problems. Thus the chapter upon coals and lignites includes several references to British materials, but there is no mention of British authors on palæobotany or its problems; and though the rock classification accepted follows the lines established by the British school of petrography, a student might read the chapter on igneous rocks and its bibliographic list without a suspicion that any British author had ever taken any interest in petrography.

At the close of the volume the author discusses the displacement of shore lines, the possible instability of sea-level, and the views of Prof. Suess, and he gives an interesting statement of the tetrahedral theory. Though he confesses that the bases of this theory are still uncertain, he thinks that tetrahedral deformation of the earth may be the solution of the hitherto unsolved problems of orogenetic movements.

J. W. G.

## *BOTANICAL PHOTOGRAPHS.*

*Vegetationsbilder.* Edited by Dr. G. Karsten and Dr. H. Schenck. Series iii. (parts 4–8), iv. (parts 1–8); v. (parts 1–8). (Jena: Gustav Fischer, 1906–7.) Price 20 marks each series, or 4 marks for separate parts.

NOTICES of earlier series of this excellent publication, that is due to the enterprise of the publishing firm of Gustav Fischer, appeared in NATURE of November 2, 1905 (vol. lxxiii., p. 4). Any doubts that may have existed as to the success of the venture have been dispelled, and it may be expected that series will follow series for some time to come. Each number containing one or more parts is complete in itself, and the various numbers in a series refer, as a rule, to different countries.

Dr. H. Schenck contributes the photographs reproduced in series iii., part 4, of trees characteristic of the Mediterranean region, of which the olive and cypress are the most important. The island of Socotra furnishes the subject of the next part. Although explored with successful results by the Forbes-Ogilvie expedition, Austrian botanists on a more recent visit also obtained many new plants. About one-third of the flowering plants are endemic, including the curious trees *Dendrosicyos socotrana* and *Adenium socotranum*, with conical swollen stems. Dr. E. Zederbauer provides the illustrations of the dry inner regions of Asia Minor. A typical scene shows scattered cushions of Astragalus and Acantholimon with interspersed plants of *Verbascum olympicum*. A double number is devoted to the small island Koh Chang, near Bangkok, where Dr. J. Schmidt obtained very successful photographs of the pneumatophores of Avicennia, Sonneratia, and Xylocarpus; a singular plant is the orchid *Eria semiconnata*, bearing button-like tubers that are studded over the rocks.

The fourth series opens with an account of myrmecophilous plants found by Mr. E. Ule in the Amazon region; species of Cecropia, Triplaris, and Tachigalia are illustrated. Two separate parts referring to German territory in West Africa are contributed by Dr. W. Busse. The former deals with primitive forests and modern steppe formations in the southern part of Togo; the other depicts economic trees such as the oil palm and shea-butter tree. Mr. C. Skottberg is responsible for a double number in which Tierra del Fuego, the Falkland Isles, and the island of South Georgia are illustrated. On the mainland, trees of Nothofagus give form to the landscape; on the islands the umbelliferous plant *Bolax glebaria*, tussock-grass, *Poa flabellata*, and *Acaena adscendens* furnish characteristic formations. Photographs of algal vegetation in the Færöe Islands have been supplied by Mr. F. Börgesen. Scenes from Arizona represent the work of Mr. C. A. Purpus. They include photographs of pines and some markedly xerophytic types, such as *Cereus giganteus*. Mr. A. Th. Fleroff has selected the water and swamp vegetation of mid-Russia for reproduction in the last part of the series.

A double number containing a continuous ecological account of the formations in the districts of the Eifel and Venn begins the fifth series. The authors, Drs. M. Koernicke and F. Roth, have shown great skill in their photographs of the ground vegetation. A number made up of three parts is devoted to photographs in northern Russia, some representing conditions in the coniferous region, others taken from the subarctic zone, that depict *Rubus chamaemorus*, *Senecio arcticus*, and "tundra" moors. Photographs of Spanish vegetation by Dr. M. Rikli illustrate the only indigenous European palm, *Chamaerops humilis*, the date palm, and esparto-grass, *Macrochloa tenacissima*. The dry season in the country around Ugogo, in German East Africa, furnishes the subject of another part contributed by Dr. W. Busse. Commiphora trees, bushes of *Adenium obtusum*, and *Acacia spirocarpa*, one of the "umbrella" Acacias, are selected for illustration. The final number in the series deals with the vegetation of the Mexican mountains Ixtaccihuatl and Popocatepetl. The author, Mr. C. A. Purpus, has selected illustrations of *Pinus Hartwegii* growing at the tree limit, and of *Senecio calcareus* and grasses in the subalpine region. *Draba Pringlei*, *Arenaria bryoides*, and *Alchemilla pinnata* are shown in the photographs of the higher Alps.

## PAINTS AND PIGMENTS.

*Analysis of Mixed Paints, Colour Pigments, and Varnishes.* By Dr. C. D. Holley and Prof. E. F. Ladd. Pp. xii+235. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd., 1908.) Price 10s. 6d. net.

*Modern Pigments and their Vehicles.* By Frederick Maire. Pp. xi+266. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd., 1908.) Price 8s. 6d. net.

THE book written by Dr. Holley, with the assistance of Prof. Ladd, on the analysis of mixed paints, colour pigments, and varnishes, should prove of considerable practical value, especially in America, and should be of assistance to analysts who have work of this kind to do, as it brings together much information which is otherwise scattered, and contains a good deal which is not to be found in the well-known manual by the late Mr. Hurst. Owing to the very large development of the ready-mixed paint trade in the United States, and the recent legislation there dealing with adulteration, the analysis of ready-mixed paints is of far more frequent occurrence than it is in this country, where it is very rare for a public body or an architect to have a proper examination made of the pigments and varnishes that they use.

The part of the book which deals with the determination of the covering power and tinting power of a pigment might certainly have been more developed. For a great many practical purposes this is a most important question. If, for instance, we take an ochre which is going to be used either to cover a surface by itself or to be mixed with white, the analysis of the ochre gives us little information of any practical value compared with its careful examination for covering power and tinting strength, yet comparatively little is said in the text-books about this method of assaying pigments. The most useful practical instrument for this purpose up to date has been the Lovibond tintometer, which enables the whole matter to be reduced to the plotting of comparative curves of tinting power, and also enables the actual covering power of a white lead to be exactly and accurately measured. The Lovibond tintometer is, however, an instrument which requires a great deal of practice before accurate results can be obtained, and recently Mr. Ives has introduced a new tintometer which may possibly replace the Lovibond tintometer for such purposes. The experiments that were made in this direction by Captain Abney resulted in the development of a most ingenious application of the spectrum, but in practice the Lovibond tintometer has so far proved the more useful instrument.

There is another direction in which the information in the book is somewhat imperfect, and that is the practical testing of varnishes, although the authors can hardly be blamed for this, as so little has yet been done to make the testing of varnishes thoroughly complete and efficient. The practical difficulties are great, and weather tests in the hands of different observers have proved to be very delusive. One of the most important questions on which there is need for far more accurate information is the durability of paints, prepared from different pigments and with different vehicles, when used for the protection of iron and steel structures. This is rapidly becoming a very serious question, as the use of steel in construction is greatly on the increase, and it is not yet possible to give very accurate information upon this matter. While, therefore, this book by Mr. Holley and Prof. Ladd may be regarded as bringing up to date the information both on the analysis of pigments and vehicles, and on the practical testing of their properties, to which the attention of chemists might well be directed, it reveals very clearly that in this department of applied chemistry a great deal more information is required to enable us to determine the facts upon which the suitability and durability of various vehicles depend.

The little book by Mr. Maire does not pretend to be a scientific treatise, but merely brings together much helpful information about modern vehicles and pigments, which is stated in a simple manner, without going into chemical details, and it should therefore prove of use to architects and house-painters and decorators who wish to have some general information as to the materials they use from day to day, and who are yet unable to understand a thoroughly scientific treatise. A fair number of the pigments which are mentioned by Mr. Maire belong rather to the artist's palette than to painters and decorators, but there is no reason why these should not be included and some reference made to them. The main difficulty of the modern decorator is, however, due to the introduction of a large number of pigments which are prepared from coal-tar dyes, fresh ones constantly coming into the market, which may be fugitive or have the property of bleeding, and about which he necessarily has no information. These pigments are introduced with fancy names, each colour maker choosing such names as may suit himself, and consequently a great deal of trouble has resulted in the painting and decorating trade. It is hardly possible for any text-book to deal efficiently with this subject, beyond giving certain general warnings that before using any new pigments, outside those already recognised, careful tests should be made by the architect and decorator.

Both these books can be regarded as thoroughly useful, the one for the analyst and the other for the architect and decorator, and should do something to encourage a more scientific study of these questions in this country.

A. P. LAURIE.

## OUR BOOK SHELF.

*A Dictionary of Spanish and Spanish-American Mining, Metallurgical, and Allied Terms, to which some Portuguese and Portuguese-American (Brazilian) Terms are Added.* By E. Halse. Pp. xiii+380. (London: C. Griffin and Co., Ltd., 1908.) Price 10s. 6d. net.

IN view of the magnitude of the mining industries of Spain, Mexico, Central America, Peru, Chile, Bolivia, and other South American countries, there can be no doubt that there is a large and increasing number of English and American mining engineers who will appreciate a good dictionary of mining terms, and certainly the author has spared no pains to make his dictionary as complete as possible. He has diligently studied the Spanish literature of mining and metallurgy, and his long residence in Mexico and in the United States of Colombia has enabled him to include a very full list of the terms used in these republics. Some Portuguese and Brazilian terms are also added.

It is curious to note that many terms have different meanings in different districts of South America. Thus, the well-known term *Caliche*, applied in Chile and Peru to the impure native nitrate of soda which is mined on a vast scale, denotes in the Uco district of Peru a thin layer of clayey soil capping auriferous veins, in Mexico felspar, and in Antioquia, Colombia, a recently-discovered mineral vein. It is probable that with the development of railway intercommunication many of these terminological differences will disappear, and that the most convenient terms will survive. In all cases the locality where a particular term is in use is noted by the author, and the authority is duly recorded. Small sketches, seventy-six in number, are added when necessary to elucidate a definition. The whole work has been compiled with scrupulous accuracy, and deserves unstinted praise. It is perhaps to be regretted that an English index to the Spanish terms has not been included in the scheme of the work.

*Immanuel Kants Metaphysik der Sitten.* Herausgegeben von Karl Vorländer. Price 4.60 marks.
*Kirchners Wörterbuch der philosophischen Grundbegriffe.* Neubearbeitung von Dr. Carl Michaëlis. Price 8 marks.
*B. de Spinoza's kurzgefasste Abhandlung von Gott, dem Menschen und dessen Gluck.* Übersetzt von C. Schaarschmidt.
*G. W. F. Hegel's Phänomenologie des Geistes.* Jubiläumsausgabe. Herausgegeben von Georg Lasson. Price 5 marks. (Leipzig: Durr'schen Buchhandlung, 1907.)

The first three of these volumes are new editions of works that have been reprinted at various times in the "Philosophische Bibliothek," a series which does for the German student of philosophy what Ostwald's well-known "Klassiker der exakten Wissenschaften" do for the German student of the sciences. Hegel's famous treatise has been added to the series in celebration of the centenary of its original publication in 1807.

The books are admirably printed, and are provided with excellent introductions, often by men of first-rate authority. Many of them are, in addition, briefly but helpfully annotated, while most are equipped with a useful index. More conspicuously moderate in price even than Ostwald's reprints, these wonderful volumes, by their very existence, render almost unthinkable any English series comparable with them in scope and importance.

*The Spectroscope: its Uses in General Analytical Chemistry.* By T. Thorne Baker. Pp. viii + 130. (London: Baillière, Tindall and Cox, 1907.)

This volume contains a fair amount of information useful to those wishing to purchase and set up spectroscopic apparatus for chemical research, but it seems to us to be ill-assorted and indifferently arranged. The author plunges straightway into the elementary mathematics of the prism and plane and concave gratings, and then describes the various parts of spectroscopes; yet on p. 78 it is thought necessary to inform the reader that a 12-inch focus telescope lens will give a much shorter spectrum than an 18-inch focus lens. There are, however, in the various discourses on adjustments, refractive indices, resolving power, the methods of producing radiation, sensitive plates, &c., numerous hints which will be found useful by those who have only a general knowledge of physics and wish to take up spectroscopy. It is for such readers that the book is intended. The notes on "series" and the Zeeman effect would probably be better left to the more advanced works on spectroscopy. There are a few uncorrected misspellings and one or two curious terms, which suggest that the author's acquaintance with real, practical laboratory work has been either too brief or too restricted. The astrophysical side of the subject is not dealt with at all, the idea being to restrict the book entirely to the chemical side. W. E. R.

*Der Bedeutung der Reinkultur. Eine Literaturstudie.* By Dr. Oswald Richter. Pp. viii + 128. (Berlin: Gebrüder Borntraeger, 1907.) Price 4.40 marks.

This essay, with true German thoroughness, gives a very complete, though necessarily brief, survey of the various microscopic organisms that have been obtained in pure cultivation. The organisms are dealt with in groups (and not individually), partly according to their biological position, partly according to the changes they produce. The green and blue algæ and diatoms are first considered, then the bacteria—the nitrifying forms, cellulose fermenters, sulphur bacteria, &c.—and lastly the yeasts and protozoa. In the final portion of the book the subjects of pleomorphism and systematic position of these organisms are discussed. The bibliography is a very full one, and it is probable that this part of the compilation will be most appreciated. R. T. H.

## LETTERS TO THE EDITOR.

*[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.]*

### The Coloration of Birds' Eggs.

In Nature of May 14 Mr. R. L. Leslie asks if it is known how and why birds' eggs become coloured, and whether they illustrate Mendelian phenomena.

Something is known as to the nature of the pigments from which the colours are derived. The late Dr. H. C. Sorby in 1875 investigated their origin by means of the spectrum analysis. He discovered seven substances in the pigments accounting for every form of coloration. These substances are oorhodeine (red), oocyan, banded ooycan (blue), yellow ooxanthine, rufous ooxanthine (yellow and reddish-yellow), a sixth substance of a brown tint, and lichenoxanthine, found in many plants, lichens, and fungi, and perhaps due to microscopic fungi. According to older theories, the pigments were secretions from the blood and bile, and in the case of the first three Sorby was disposed to agree (*cf.* the origin of pigments in coloration of molluscan shell). The ground-colour is laid on the shell just before the extrusion of the egg, and in eggs not of a purely uniform colour the markings are then superposed, being originally rounded, but by movement of the bird they become blurred and blotched. The intensity of coloration varies with age up to a certain point. Eggs of young birds are often unspotted. No doubt absence of markings is due to deficiency of pigmentation. The last egg or eggs of a second brood, in fact, often lack normal coloration or markings. Age and health thus control coloration, which is brilliant in a healthy but indistinct in an unhealthy bird's egg. Whether albino birds lay eggs differing from those of birds typical in every way has not been noticed apparently.

Little is known definitely as to why eggs are coloured.

In the early days of ornithology oology played its part in classification, but though the eggs of plovers, gulls, &c., characterise their suborders, this is rather exceptional than otherwise, and Huxley has settled the question of avian taxonomy upon a sound morphological basis. Coloration of eggs seems to have no connection with inherent hereditary tendencies, nor is it apparently the result of acquired characters in the birds themselves. In a large number of cases it can be traced to the necessity for a protective resemblance, just as in shells of mollusca. This would serve to ensure escape from the jaws or beaks of natural enemies, *e.g.* hedgehog, snakes, and egg-sucking birds and mammals, or (in recent times) from the collecting instinct of man. Where eggs exhibit brilliant or conspicuous markings, for no purpose apparently, we may perhaps assume that the nesting-site has been modified, or that, like the colour of the plumage, that of the egg is a source of attraction, and connected with courtship, or, more probably, as a means of identification by the individual of its own nest and eggs, when the process would naturally be hereditary (memory and heredity being intimately allied), the instinct employed in distinguishing similar clutches characterised by merely slight differences being likewise acquired.

No two clutches of eggs of the same species are exactly alike, particularly amongst birds nesting in colonies, *e.g.* guillemots, penguins, &c., but each bird knows its own egg. A few general principles may be recognised in the coloration of birds' eggs. Usually white eggs are laid by birds nesting in holes in trees or in dark situations, where light seldom penetrates, as by the barn owl, woodpeckers, and some pigeons, which build sometimes in the open, though usually in dark woods (wood-pigeon), sometimes in holes in trees, or in rabbit-burrows (stock-dove). Though all owls lay white eggs, not all of them nest in holes in trees, *e.g.* long-eared owl, snowy owl. This rule, then, holds good in a large number of cases, but not invariably. Most birds nesting on or near the ground lay eggs of a uniform olive-green or brown ground-colour, *e.g.* pheasant, partridge, nightingale, &c., the eggs harmonising with the ground or vegetation.

The eggs of grouse, ptarmigan, &c., resemble the heather amongst which they are hid. Those of the ringed plover, little tern, and oyster-catcher resemble sand and shingle on the beach. The lapwing's eggs closely simulate bare soil or dried bents. In these eggs secondary markings break up the ground-colour, and further help to render the eggs quite invisible except to an eye trained to detect slight differences. The experienced field naturalist can find his way to the immediate whereabouts of a nest by noticing the existence of some distinctive mark in the surroundings, *e.g.* a stick, boulder, bush, mole-heap, &c., indicating to the birds themselves at a distance the vicinity of the nest, and thus enabling them to return quickly and stealthily without laying themselves open to observation by long searching for the nest. The same protective resemblance occurs amongst the chicks of these birds. Adaptation to external surroundings, now or in the past, seems to explain this matter of coloration in a large number of cases, and exceptions to the rule are usually simply examples of reversions to, or rather survivals of, ancestral traits before protection was called for. In seeking for the causes of variation, &c., the influence of environment or external conditions seems to have been largely overlooked, too great prominence having been given to the influence of the inherent tendency to vary. In the case of the colours of birds' eggs we have an instance in which, I think, external conditions have played the greatest part.

Whether all birds' eggs were originally white, and the pigmentary layer has since been added to aid in concealment or to counteract the heat of the sun's rays, is not definitely known. The number of eggs ornamented with spots, &c., is very great. The creepers, nut-hatch, &c., lay spotted eggs in holes in trees, &c., possibly after originally having had some other nesting-site.

Summing up the general conclusions drawn from the coloration of birds' eggs, we find different species of birds of the same genus in a large number of cases lay eggs of much the same type, *e.g.* warblers, tits, nut-hatches, creepers, plovers, ducks, pigeons, gulls, terns, &c. In very many cases, however, this is not the case, and an exception in any genus may generally be traced to influence of environment. Amongst the Turdidæ, the eggs of the missel-thrush, thrush, and blackbird are very dissimilar, though their nesting sites are much alike. Variation in the colours of eggs goes, in fact, largely with difference in nesting-site. The starling and jackdaw lay blue eggs like the three last-named birds in holes in trees. Probably these birds have only recently betaken themselves to such nesting quarters. The influence of man and his habitations, and the conversion of dark forests into fields simply enclosed with *lines* of trees into which light readily penetrates, may have induced alterations in some instances, if not in coloration of the egg, at least in nesting-sites, of many birds intimately associated with human undertakings.

A. R. HORWOOD.

Leicester Corporation Museum, May 26.

## Electrical Action of Sodium.

IN a recent letter (NATURE, May 28) I directed attention to the fact that a negatively electrified body lost its charge in air when held near to a clean surface of sodium.

I have now ascertained that different portions of the same rod may show the effect to a greater or less extent owing to inequalities of temperature. Diminishing the oxidation by cooling the metal produced a more complete diselectrification, and this result seemed, at first sight, to point to a cause other than chemical action. The influence of a current of air, as well as the fact that even a soap film stopped the discharging action, supported the view that an electrified gas was emanating from the metal. A bright surface of potassium gave no appreciable discharging effect when cooled with a mixture of ice and salt. In all cases the surfaces could be seen in the dark to be glowing strongly.

Further experiment has shown that no active gas can be driven from sodium by heat, and that the true explanation of the action lies in the positive electrification of the air surrounding the freshly cut surface. With warm sodium it is seen that the gold leaf falls rapidly for a very short distance, while after cooling the action is more prolonged. It is clear, therefore, in the first case, that the action, although violent, is so transient, owing to the whole surface being rapidly oxidised, as to appear of small amount. The far larger discharging action was obtained with reduced oxidation owing to the effect being more prolonged.

CHARLES E. S. PHILLIPS.

Castle House, Shooters Hill, Kent.

## Tabular Accuracy.

I DO not know whether you will consider the following suggestion suitable for publication. Though obvious, I do not remember meeting with it.

All are agreed upon the enormous importance of securing accuracy in mathematical tables, and of making known any errors, but I am not aware of any definite centralised method of registering mistakes, and publishing, in an easily accessible form, corrections of them.

What I venture to suggest is that, in connection, say, with the National Physical Laboratory, there should be a department dealing with mathematical tables. When an error is discovered in any recognised table, the discoverer should at once send a note of the fact to this department, which would duly investigate the matter. Then, at suitable intervals, the department would publish a list of errors, with their corrections, in a form purchasable by those interested. By some such arrangement he might hope in time to secure the accuracy so essential to the numerical data employed in scientific calculations.

C. T. WHITMELL.

Invermay, Hyde Park, Leeds, June 2.

## The "Sky-coloured Clouds."

THERE was a very feeble display of "sky-coloured clouds" here on May 27 from 10 to 11.15 p.m. This is the first time I have seen this phenomenon since July 19, 1906. Since May 27 the sky has not been clear enough for them to be visible.

T. W. BACKHOUSE.

West Hendon House, Sunderland, June 4.

## SOME SCIENTIFIC CENTRES.

### No. XIII.—THE MECHANICS LABORATORY OF THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY.

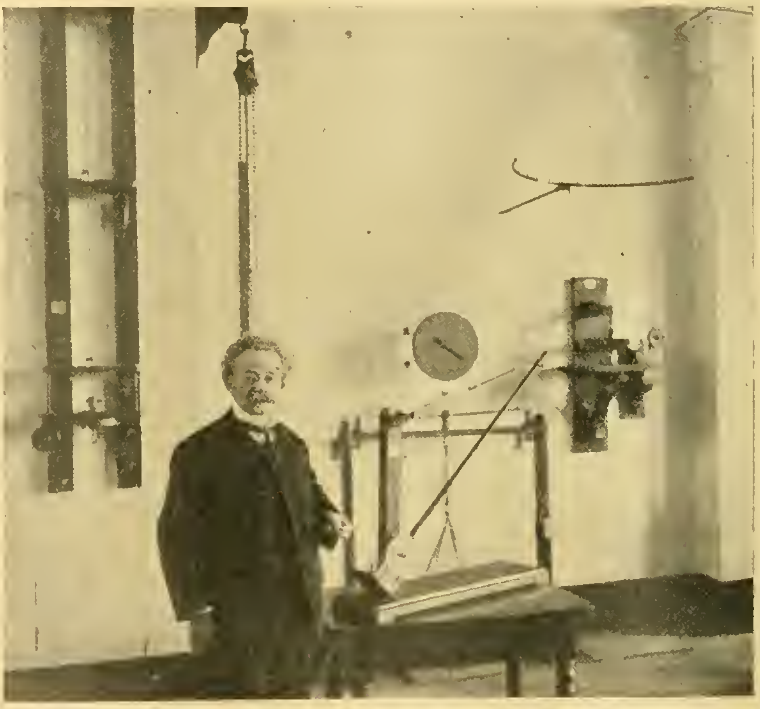
THIS description of the mechanics laboratory of the Imperial College of Science and Technology may not improbably appear to some readers as premature, in consideration of the fact that the college was so recently founded and the new rector, Dr. Bovey, appointed only within the last few months. It was as the mechanics laboratory of the Royal College of Science that until lately it was known, and under that name it achieved the great success that time and Prof. Perry brought to it. What that laboratory has been for the past ten or more years to engineering students in London will not readily be forgotten by Prof. Perry's old students, and a piece of creative work of this kind is too valuable to be lost. It is therefore a matter for congratulation that the laboratory has found a place in the new Imperial College, and in doing so it has, we hope, taken a new lease of life and usefulness.

The new Imperial College will assume also the control of certain engineering laboratories, but it must be remembered that the study of mechanics is not the same thing as the study of engineering. Not all who attend a mechanics course become engineers, though, while they are pursuing that study, the more they conform to the engineer's mental attitude, the better will they understand what they are doing, and the more effective use will they make of the time spent on this subject.

Engineering laboratories are now so numerous that they must be familiar to all who are interested in scientific work. As a type, probably the best example is to be found in the University of Cambridge. In that laboratory, for instance, there are steam engines, dynamos, motors, gas engines, boilers, oil engines, storage cells, indicating instruments, and all the hundred-and-one accessories. The atmosphere is far more nearly that of the power-station or the test-bench of a works than that of the college class-room. To complete an engineering course it is necessary to spend some time in these surroundings at Cambridge or elsewhere, but unless the student has some preliminary training in mechanics the soil will be but ill prepared for the seed.

When in 1896 Prof. Perry was appointed to the chair of mechanics and mathematics in the old Royal College of Science, he set himself to organise and equip a laboratory for the study of mechanics. It was extraordinary how the course could have prospered before without something of the kind, and the new departure meant a good deal of hard work in getting it carried out. In spite of all difficulties, however, the scheme was successfully carried through, and visitors to the college have for some years been able to see what is the model mechanics laboratory of this country. Prof. Perry himself states that his laboratory methods of teaching are based on those introduced by Prof. Ball (now Sir Robert Ball, of Cambridge University) when at the Royal College of Science in Dublin, and were gradually developed by him at Clifton College between the years 1870 and 1874. A further opportunity of development occurred during his tenure of an engineering chair in Japan from 1875 to 1879, with the consequence that by the year 1880 they blossomed out into a matured scheme of teaching at the Finsbury Technical College. It is a remarkable fact that almost all the technical institutes in this country now have, or are in process of forming, mechanics laboratories which, like the one which forms the subject of this article, are based upon the model of "Finsbury." The idea at the basis of this teaching is that students should test for themselves the truth of the theories they learn, and not get into the frame of mind which looks on all theories as equally true because all are put forward with a generally similar show of authority.

To take a simple instance of this, the problem presented by the phenomenon of friction may be cited.



Prof. Perry in his laboratory at the Imperial College of Science and Technology.

In the days before engineering had become a scientific study, the phenomenon of friction was part of the domain of the mathematical physicists, who, being chiefly desirous of finding quickly relations between different variables which would enable the data to be put into the mathematical mill to the end that results might be ground out, did not scrutinise with nearly sufficient care the results of their experiments. This was not altogether their own fault, as the apparatus used was rarely well designed to give accurate results, and their own training was extremely ill fitted for such work. For good or ill, however, the theories, such as they were, were formulated, received the name of "laws," and then there came into being those curious survivals known as the "laws of friction," so familiar to all who were still students ten or more years ago. In the early days of scientific engineering education, let us say during the 'fifties and 'sixties of last century, when the Prince Consort gave so nobly his assistance to the furtherance of the new movement, young engineers found themselves required to learn for the purpose of examinations "facts" which they were well aware from their own experience to be misrepresentations of the real state of affairs. Among the men who have since helped to put these students into the right path and to help them on the way, none were more prominent or are more deserving of praise than Prof. Perry.

In his laboratories the phenomenon of friction, to take this same instance, is dealt with in such a way as to give the student opportunity to exercise all his knowledge of mechanics. Thus he has to test the effects of friction in every part of a mechanism—he is not allowed to forget its existence or to have his mind taken away from it, as may happen so easily when working among the large and complicated machines of the engineering laboratory. Even in so simple a case as that of the spinning of a horizontal fly-wheel by means of the unwinding from its axis of a rope which passes over a pulley, and carries a weight at its far end, the number of problems that arise is very numerous. To instance the variety of information which can be derived even from such a simple experiment as this, we may quote the following from Prof. Perry's "England's Neglect of Science":—

"Let us take this well-used fly-wheel. The M of a fly-wheel, multiplied by the square of its number of revolutions per minute, gives the kinetic energy stored up in it in foot-pounds. You are asked to measure experimentally the M of this fly-wheel; the loop at the end of a cord goes over the pin A on the spindle, and is wrapped $n$ times round the spindle, then goes over the pulley B, and has a weight W at its end. At time O the wheel is let go; in $t_1$ minutes—carefully observed—the cord drops off; in $t_2$ minutes from starting the wheel has been brought to rest again by friction. The weight W lb. multiplied by the height in feet through which it has fallen gives the energy stored up in the wheel at time $t_1$, so that if the speed were then known M could at once be calculated. But as we have no speed indicator, we take it that the motion is uniformly accelerated till the cord drops off or we take $2\frac{n}{t_1}$ as the revolutions per minute at the time $t_1$. The corrections are of more interest. We have first to deduct the kinetic energy of W when the cord drops off. Then we must make experiments on the friction of the pulley B, for the pull in the cord at C is less than what it is at D, and these experiments are themselves very interesting, for they are made with the two parts C and D vertical, so that the parallelogram of force principle must be brought in to make them available. Next we correct for the friction at the pivots E and F. And here we observe that the average speed from $t_1$ to $t_2$ is the same as from O to $t_1$, and hence that from $t_1$ to $t_2$ the motion is uniformly retarded, and hence that there is as much energy wasted in any one revolution as in any other. If, then, we know the number of revolutions from $t_1$ to $t_2$ we know the energy wasted in one revolution, and we can correct for friction before the cord drops off, and so we make one correction after another, and there is hardly any limit to the amount of ingenuity required, as the corrections get less and less important. I remember that four grey-headed men worked together once at this piece of apparatus in the evening for five weeks, and when at length they had satisfied themselves with their corrections they had practically used many times every important principle of mechanics, and they had acquired a handy working knowledge of all these principles."

It is hardly possible to set bounds to the usefulness of such calculations as the above in making students think for themselves and, if they have even a moderate acquaintance with mathematics, in assisting them to find themselves, even unwittingly, engaged on what is really an original piece of research.

A mechanics laboratory is by its constitution less adapted than an engineering laboratory to research work of the usual kind, but during the last few years an important piece of original work on the air friction of rotating paper discs has been carried out. A note on the preliminary experiments was read before the Southport meeting of the British Association in 1904 by Mr. W. Odell. Mr. Odell's experiments consisted in measuring electrically the torque necessary to keep in uniform rotary motion circular discs of paper which were mounted on a horizontal shaft. These discs were 15, 22, 27 and 47 inches in diameter, and the torque was measured for (1) different speeds, (2) different diameters. The very interesting result was found that, once the critical speed was passed, the torque was proportional to the $n$th power of the speed, and that $n$ was about 2·5. It was further found that the critical speed was roughly proportional to the square of the diameter when different discs were used. For a given speed the torque increased with the 5·5th power of the diameter, and this striking result leads to the deduction that, 6 watts only being required to keep a 27-inch disc moving steadily at 550 r.p.m., no less than 32 h.p. would be necessary to keep a 9-feet disc rotating at the same speed. This deduction has a very important bearing on the design of high-speed generators and other machines in which the rotating parts have considerable diameter. Roughly, a one per cent. increase in diameter would lead to an increase in the necessary torque for the same speed to be obtained of no less than $5\frac{1}{2}$ per cent.

A similar plan is followed in the laboratory with regard to problems connected with the torsion of shafts, the flow of water, the bending of beams, the efficiency of mechanisms, the swinging of pendulums, and others of the same kind. The result of such a training on students is that they acquire a kind of instinct in mechanical matters, one which is difficult to describe, but which develops alertness, and would, for instance, lead such a student to doubt immediately the accuracy of the usual measurement of horse-power by means of the average indicator. Even with such a well-made instrument as the Hopkinson reflecting indicator he would not omit to make calculations as to the effect of inertia lag when rapid explosions were being recorded, the effect of damping, and other points. After doing this he would appreciate the more the modest claim of the inventor of a 2 per cent. accuracy, and contrast it with the far more heavily drawn claims of instruments much less carefully designed. To instil this attitude of mind into young students, that they should "test all things" and take nothing for granted, is to lay the basis of a scientific way of thinking which is of fundamental importance to them in after years.

H. E. W.

## THE MILKY WAY.[1]

It may be that the limitations imposed upon us by restrictions in time and space will never allow a complete solution of the problems offered by the study of the sidereal universe. But the effort to comprehend the processes that have contributed to its structure, or

[1] (1) "La Distribution des Étoiles par rapport à la Voie lactée d'après la Carte et le Catalogue photographiques du Ciel." Par Paul Stroobant. Extrait des Annales de l'Observatoire royal de Belgique, Annales astronomiques, Tome xi., Fascicule ii.
(2) "Die Milchstrasse." By Prof. Max Wolf. Pp. 48. (Leipzig: J. A. Barth, 1908.) Price 4 marks.

to penetrate the mystery that conceals its destiny, will not be abandoned on account of the difficulty of the problem or the dearth of pertinent facts. There may be little hope that our observations and those of our predecessors will prove adequate to the task of reading the riddle, but the human mind needs very little information to tempt it to form conjectures concerning the order of creation in its widest extent. In this department of science, history unfortunately bears witness rather to the richness of our imagination than to our skill in securing facts. But in recent times, as the contents of the two works under notice show, the tendency has been to limit our excursions into the unknown, and to substitute exact inquiry directed to a definite end, in place of the loose, but possibly plausible, suggestions that did duty for critical examination. In the first-mentioned work M. Stroobant is content to count the stars the positions of which have been recorded in connection with the scheme for the construction of the photographic chart of the heavens. Such work is no doubt tedious and unheroic, but it is eminently useful, and more welcome than any random speculations, however brilliant or startling they might be. The object the author had in view in undertaking this wearisome task was to determine the law of stellar distribution, both on the chart and in the catalogue, according to variation of galactic latitude. For the present the research is limited to the stars in the zones taken at the observatories of Paris, Bordeaux, Toulouse, Algiers, and San Fernando. Of the star charts 879 have been used, containing the total of 985,430 images; and of the catalogue negatives 535, which show the places of 163,009 stars. The celestial surface scrutinised contains 4126 square degrees, approximately one-tenth of the entire surface of the sphere.

One of the by-products of the research is to indicate that the mean magnitude of the faintest stars recorded on the catalogue plates is 11·5 mag., and that of the faintest stars on the chart 13·5 mag., or taking into account the loss of images, unavoidable in reproduction, 13·7 mag. These figures show, so far as this inquiry is trustworthy, that the original proposals for the construction of the international chart have been adhered to very faithfully. A further conclusion is that the total number of stars we may expect to find in the complete catalogue is 2,676,000, and on the chart 9,854,000. These totals are more modest than early and less informed estimates, and M. Stroobant gives reason to think that these numbers will be exceeded when some of the unpublished charts become available. The data supplied from each observatory are discussed separately and fully, but space will not permit more than the reproduction of the final result, which exhibits the conclusions drawn from the whole material under discussion :—

| Galactic Latitude | No. of stars in square degree | | Stellar density | |
|---|---|---|---|---|
| ° ° | Chart | Catalogue | Chart | Catalogue |
| +90 to +70 | 91 | 30 | 0·14 | 0·19 |
| +70 ,, +50 | 83 | 29 | 0·13 | 0·18 |
| +50 ,, +30 | 140 | 48 | 0·21 | 0·30 |
| +30 ,, +10 | 337 | 90 | 0·51 | 0·57 |
| +10 ,, −10 | 660 | 159 | 1·00 | 1·00 |
| −10 ,, −30 | 344 | 83 | 0·52 | 0·52 |
| −30 ,, −50 | 130 | 39 | 0·20 | 0·25 |
| −50 ,, −70 | 111 | 24 | 0·17 | 0·15 |

The want of exact regularity in the change of these numbers with the latitude is doubtless due to insufficient data, but considering the number of stars involved and the care taken to secure uniformity, the result is probably more trustworthy than that drawn from Herschel's gauges, which indicate a much more rapid increase in stellar density as the latitude diminishes. Further examination shows that the number of stars on the chart increases uniformly in both hemispheres, but that if the faintest stars be excluded and the research limited to those that appear in the catalogue, the density is more marked in the northern than in the southern hemisphere. It is not possible to make any complete inquiry as to the variation of density depending on galactic longitude, but from a preliminary investigation of those regions of the Milky Way where it cuts the celestial equator, M. Stroobant shows that at the ascending node of the Galaxy, the northern border is richer in stars than the southern, and that at the descending node this relation is reversed. It is further pointed out that the increase in the number of stars on the photographic chart does not correspond with the contour lines drawn in naked-eye representations of the Milky Way, and in conclusion the author directs attention to regions of the sky which are very rich in stars, though fairly remote from the central line of the Milky Way, to the pole of which are assigned the coordinates $\alpha = 12h.\ 46m.$, $\delta \pm 28°$.

Prof. Max Wolf addresses himself to a scientific congress, mainly composed of medical men, and necessarily his paper is of a more popular character. He frankly admits that we have but very little knowledge of the true construction of the Milky Way, and that speculation has supplied the place of exact information. By means of excellent photographs he shows the great variety of structure running throughout the Galactic Belt, and indicates the difficulties which any theory of the Milky Way has to surmount. Prof. Max Wolf is intimately acquainted with the literature of the subject, knows the strength and the weakness of the various hypotheses that have been advanced, and treats the many problems that arise in a luminous and interesting manner.

He glances at the various studies that have been made to solve the problem of the possible geometrical form of the Galaxy, from the time when Herschel began his laborious task of counting the stars visible in the field of his telescope, down to that later period when the resources of photography have supplied more information, but at the same time revealed a more complex structure, offering fresh difficulties for solution. Of the different attempts that have been made to represent its true shape, concealed as it is by the curious bifurcations, rifts, condensations, and lacunæ, that suggested by Dr. Easton, of Amsterdam, meets with the greatest favour. In this scheme the Spiral Nebula in Ursa Major has admittedly supplied the model. A nucleus is placed in the constellation Cygnus, and from this central condensation radiate streamers, which can be arbitrarily arranged so that the combined effect can be made to resemble the general aspect of the Milky Way. The objection the author raises to the scheme is that Cygnus does not present that close agglomeration of stars which such an hypothesis requires. It might further be added that in the sketch given, the sun occupies too much the place of a detached spectator, and is apparently quite disconnected from the system.

A feature of great prominence in many photographs of nebulæ is the comparative scarcity of stars in the immediate neighbourhood of the nebula, and Dr. Max Wolf discusses the probable physical connection between the dark lacunæ and the brilliant condensations adjoining. This effect is real, and not due to contrast, for by counting the stars on a photograph within a definite area, and shading the different parts of that area according to the number of images impressed on the film, it is possible to exhibit statistically the relative density of stars surrounding the different nebulæ. This plan has been adopted with great success in the most important nebulæ and clusters, and the diagrams reproduced show the completeness of the connection. The most conspicuous, as it is one of the most interesting instances, is that known as the "cocoon" nebula, where the complex nebulous structure lies concealed at the end of a long channel, extending more than two degrees into the luminous clouds. The author suggests that we have here to do with an absorptive phenomenon, and certainly the appearance warrants the suggestion. But such instances, if less pronounced, are not rare, and therefore it is legitimate to imagine that the whole heavens are more or less hidden by the results of processes still in progress. In that case the Milky Way itself may be regarded as a remnant of an earlier much more extended universe. This hypothesis, as any other we may form, may be quite misleading, but into whatever errors our assumptions may conduct us, it is certain that the Milky Way offers a grand and sublime problem, indicating the action of processes and forces for the adequate description of which we still lack rudimentary conceptions. We stand face to face with a great mystery without the partial unveiling of which our pictured scheme of the cosmos must remain an imperfect patchwork.

## *SIR JOHN EVANS, K.C.B., F.R.S.*

BY the death of Sir John Evans, British archæology has lost one who was amongst its foremost figures for more than fifty years. The son of the late Rev. A. B. Evans, D.D., he was born at Britwell Court in 1823, educated at Market Bosworth School, and entered the business of his maternal uncle, Mr. John Dickinson, F.R.S., the founder of the famous paper factory at Nash Mills. From school young Evans brought with him a genuine love of classical literature and history, and presently he developed a no less strong taste for science, whilst he at once showed business capacity of no ordinary kind. Very soon he directed his attention to geology. Practical reasons may have hastened a natural tendency, as he was led to this study by a dispute respecting the water rights of his uncle's firm, and in a comparatively short time he mastered the principles of that science. He became an active member of the Geological Society, of which he was elected president in 1874.

Sir John Evans's scientific training had a very important bearing on his work as an archæologist, and in no little degree enabled him to make those great advances in British archæology which that science owes to him. Scientific method, combined with his love of historical literature, gave him an equipment for antiquarian studies possessed by but few of his contemporaries. Evans's interests were of the widest, but in his early years they chiefly lay in the coins of the ancient Britons. Though from Camden onwards much had been written about them, Evans for the first time coordinated the entire mass of material, and worked out systematically the evolution of the British types, as Lelewel had done for the Gaulish series and partially attempted for Britain. When, in 1864, Evans published his "Coins of the Ancient Britons," it was at once recognised, not only as a masterly example of learning and minute accuracy of detail, but also as a model of method. He published a supplement to it in 1890, and though his chronology, based on the time supposed to be necessary for the degradation of the original type of the gold stater of Philip II. of Macedon, may not now commend itself, the book must always remain one of our chief authorities for the early history of this island.

But his attention was not confined to the period between the occupation of south-eastern Britain by the Belgæ and the Roman conquest. He worked incessantly at the remains of prehistoric man both on the Continent and in these islands, following the method of the great Scandinavian archæologists. The first results of these labours were embodied in "The Ancient Stone Implements," &c., of Great Britain, published in 1872 (second edition in 1897). Here, of course, his geological knowledge came into play, more especially in reference to the relics left by Palæolithic man in the fluviatile gravels of our own island. Yet all this time he had been working incessantly at the first beginnings of the use of metal, and the fruits of his work in this all-important field were put forth in "The Bronze Implements of Great Britain and Ireland," in 1881. All his three great works are largely based upon and illustrated from his own magnificent collections in the several departments, though these were but a fraction of his vast treasures, which comprised a great series of Greek, Roman, English, and other coins, medals, rings, enamels, and most other classes of antiquities. At a time when so many objects which form an integral part of our national history are constantly finding their way across the Atlantic, it is pleasant to think that the collections amassed at Nash Mills are not to be dispersed under the auctioneer's hammer.

Besides his three master-works, Evans wrote innumerable papers in *Archaeologia*, the *Numismatic Chronicle*, and various other journals, all of which are distinguished by the same rigorous accuracy and keen insight as his larger publications. It is hard for us in this generation to realise clearly all that he did to advance the study of archæology in this country. Though Worsaae and his school had already firmly laid down the principles of archæology in Scandinavia when Evans began his career, in this country such studies were almost entirely in the hands of the Oldbucks and the Simpkinsons, whose fatuities, credulities and wild speculations were scorned by serious historians and mocked at by the general public. Evans's strong common sense, his scientific training, and his instinctive love of historical records soon made him a powerful steam-hammer which pulverised mercilessly the trivialities and inanities of the old antiquarians. To his influence is due in no small degree the hold which scientific archæology has been able to get on the respect of men of science, historians, and the general public. The fact that he was a most successful man of business, and at the same time took the lead in the public affairs of his county, contributed in no small degree to this result. It was felt by men of the world and men of science alike that if so powerful and practical a mind could find its chief interests in the pursuit of archæology, these studies deserved better than to be the mere pastime of pedants or enthusiasts.

Evans's great characteristics were his strong common sense, his courage, and his extraordinary mastery of details, though the last became sometimes even a weakness. Thus, whilst his books on the Stone and Bronze ages are vast storehouses of facts and minute and accurate details, he sometimes lost sight of the general principles, and did not always lay sufficient stress on the importance of associated groups of objects to which the younger generation attaches so much value. But make what deductions we may, the fact remains that Sir John Evans must always hold his place along with John Kemble, Wollaston Franks, Greenwell, and Boyd Dawkins in the front rank of those who have set British archæology on a scientific basis. Vigorous in defence of his own views, yet from his innate love of truth ready to modify them and accept those of others when his reason was convinced, his strong and masterful disposition made him a leader of men, and thus he became in due course president or chairman of almost every society, association, or public body of which he was a member. His delightful humour and inexhaustible fund of good stories made him the best of companions. Time dealt with him kindly; he bore lightly his burden of more than four-score years, and to the last his mind retained its youthful spring. The sturdy old oak continued green and vigorous until the axe was laid to its root. His genial presence will long be missed at the British Association and numberless other bodies at which he has been a familiar figure for more than half a century. W. R.

## *NOTES.*

THE Albert medal of the Royal Society of Arts for the present year has been awarded to Sir James Dewar, F.R.S.

ON May 30 Her Majesty the Queen of Holland nominated Sir William Ramsay, K.C.B., as a member of the Dutch Academy of Amsterdam in succession to the late Lord Kelvin.

IN the House of Commons on June 3 Sir William Anson asked the President of the Board of Education whether, having regard to the insufficiency of the present temporary buildings at South Kensington for the housing and display of the collections of scientific instruments and apparatus belonging to the Government, and to the importance of making these collections useful to teachers and students of science, and to the Imperial College of Science and Technology, he would consider the advisability of erecting a suitable building for a science museum on the site of the existing temporary galleries. In reply, Mr. McKinnon Wood said:—"I think it would be eminently desirable that there should be a science museum properly housed in immediate propinquity to the Imperial College of Science and Technology, and if the Commissioners of the 1851 Exhibition feel themselves in a position to cooperate, I should be happy to bring the matter under the notice of the Chancellor of the Exchequer; but it is obvious that any steps requiring the financial assistance of the Government could only be undertaken with due regard to the general calls upon the Exchequer."

IT was announced some time ago that the Zoological Society of London was arranging for a special exhibition of Australian and New Zealand animals in the society's gardens. Dr. P. Chalmers Mitchell, F.R.S., now informs us that the Governments of New Zealand and New South Wales have each made presents to the society of some of their peculiar birds, mammals, and reptiles, and a very fine collection has been got together from the various Australian colonies. Mr. Seth-Smith, a member of the council of the society, proceeded to Australia last December to make the final arrangements for getting the collection together, and two keepers followed him early in the year to take out a number of animals from the gardens in Regent's Park for the Australian gardens, and to take charge of the returning collection under the direction of Mr. Seth-Smith. The animals left Australia in the White Star liner *Persic* in April, and arrived at Tilbury on Saturday evening. The detailed list is not yet to hand, but from advices the society has received it is certain that the collection will be the most representative one of marsupial mammals and peculiar birds and reptiles of Australia ever got together either in Australia or in Europe.

BY the death of Admiralitäsrath Carl Koldeway, which occurred at Hamburg on May 19, Germany has lost a distinguished seaman whose scientific investigations have proved of great practical value. Captain Koldeway was born on October 26, 1837, at Bücken, Hanover, and commenced his career as a sailor in 1853. In 1866 he studied at the polytechnic at Hanover, and in 1867 at Göttingen. He commanded two German North Polar Expeditions during the years 1868–70, the first to Spitsbergen, and the second, with two ships, to north Greenland, where he wintered and made important discoveries. In 1871 Captain Koldeway was appointed first assistant to the Seewarte at Hamburg, and four years later became director of the second section for magnetism, and for the testing of nautical and meteorological instruments. He was specially interested in magnetism, and was entrusted with the compensation of compasses for deviation on board ships of the mercantile marine. In addition to the accounts he published in reference to his voyages to the Arctic regions, he was the author of many valuable papers on magnetism, meteorology, and oceanography, among which may be mentioned "Change of Magnetism in Iron Ships, based on Observations for Deviation" (*Deutsche Seewarte Arch.*, 1879), "Results of Meteorological Observations at Spitsbergen and East Greenland" (*Zeitschrift Meteorol. Vienna*, 1876), "Surface Temperature in the Equatorial Regions of the Atlantic Ocean" (*Annalen Hydrogr.*, 1875).

A LETTER by Dr. W. N. Shaw, F.R.S., in Saturday's *Times* contains some cogent reasons against the adoption of the proposals in the Daylight Saving Bill, to which reference has been made in these columns on several occasions. In the first place, Dr. Shaw remarks that a large number of meteorological instruments in many parts of the country are designed to record continuously day and night. Are these instruments to run an hour wrong for six months or are meteorologists to use a time system different from that in use in the country? All the operations of meteorological observers would be affected by the change contemplated by the promoters of the Bill, and the passing of an Act to change the standard time twice a year would have to be followed by an instruction to meteorological observers to adhere to the old times for their observations, whatever it might be called according to the clocks. Part of the work of the Meteorological Office, Dr. Shaw points out, is represented by a system of daily telegraphic reports of synchronous observations upon which the weather reports are based. The system is an international one, and this year an important step is being made towards the ideal of international as well as national synchronism. It is important, therefore, that there should be no misunderstanding as to the time standards employed. Dr. Shaw writes feelingly when he says that no one who is concerned with the preservation of records for long series of years to be consulted when all possibility of clearing up ambiguities has passed away can regard the idea of a dual time system with anything but blank dismay. It is curious that in this connection he does not refer to the impossibility of comparing thermometer readings in summer and winter if the change were adopted. The seasonal meddling with the clocks cannot, in fact, be justified from a scientific point of view, and would lead to hopeless confusion in records in which time is a factor. There is no reason why individuals should not practise self-deception to the extent of putting their clocks back or forward as they wish, but for a nation to be compelled to do this by legislation would be the height of folly. It is too much to expect that men of science busy with their own affairs should have to devote their time to the preparation of evidence to show the Select Committee upon the Bill the disturbing nature of the scheme proposed; but as to the weight of competent opinion against the Bill there can be no question.

The Institution of Electrical Engineers will hold a conversazione at the Natural History Museum, South Kensington, on Thursday, June 25.

To a new species of amphipod crustacean inhabiting sand at the roots of trees at Punta Arenas, Costa Rica, the Rev. T. R. R. Stebbing (Proc. U.S. National Mus., vol. xxxiv., p. 241, No. 1609) gives the name *Orchestoidea biolleyi*.

As the result of recent legislation for regulating the importation of wild animals which might possibly become acclimatised in the United States, the Zoological Society of Philadelphia, according to its report for 1907, finds a marked diminution in the number of specimens received during the year. Although, runs the report, the wisdom of preventing the introduction of objectionable animals is not to be questioned, "regret may be expressed that the minute and vexatious details which must be complied with on bringing into the country even single specimens by casual travellers or steamship-employes, imposes this serious limitation upon zoological gardens."

From America we have received a batch of pamphlets dealing with the protection and encouragement of birds. Among these is one issued by the National Association of Audubon Societies on the winter-feeding of wild birds, and a second on the best methods of constructing and placing artificial nesting-places. Statutory bird-protection in Massachusetts forms the subject of a pamphlet sent out by the Board of Agriculture for that State, while some of the commoner birds of Oregon are described and figured in a tract issued by the Oregon State biologist. The claim of the Virginian quail to considerate treatment by the agriculturist is urged by Miss E. A. Reed in a leaflet published by the aforesaid association under the title of "Bob White the Farmer's Friend"; while, finally, we have the first annual report (illustrated by an excellent coloured plate of the wood-duck) of the good work by the Audubon Society of South Carolina during its (at present) short career.

To the *Century Magazine* for June, Mr. G. H. Thayer contributes an article on the concealing (protective) coloration of animals. The article, which discusses the problem from the point of view how and to what extent—and not why—animals are protected by their colouring, is mainly based on the experiments conducted by the well-known artist Mr. Abbott H. Thayer, which were reviewed in Nature in April, 1902, and are represented by a case with models in the natural history branch of the British Museum. The author re-asserts the claim of this artist to have discovered that the arrangement of light and dark colours on the upper and lower surfaces of the bodies of animals is a factor of much more importance in rendering them invisible than is an agreement between their own colouring and that of their environment. This is graphically illustrated by means of photographs.

Nearly the whole of the April number of the *American Naturalist* is taken up with the report of a "symposium" on the species-question which took place at a meeting of the American Botanical Society held at Chicago in January last, where various speakers discussed the topic from the point of view of their own special line of study. The first speaker urged that we are in danger of destroying the usefulness of taxonomy in our zeal for describing every differing form as a separate species. We have lost sight of the primitive reason for the formation of species, namely, that we should have fewer things to hold in mind. A second referred to the statement made by ornithologists to the effect that a species may differ by characters which cannot be put into words, so that it can only be recognised when placed alongside specimens of its nearest relatives. In opening a general discussion on all the papers submitted to the meeting, Prof. J. M. Coulter remarked that all the speakers seemed in accord as to the need for action of some kind, and that the idea of a species must be modified. He himself favoured the plan of continuing to name easily recognised forms, calling them species if desired, and then to indicate minor distinctions by numbers. By this the excessive multiplication of names would be avoided, while an exact record would be established. This plan is to a great extent a modification of trinomialism—with the important difference that the third term in the name is discarded in favour of a number.

The degree to which trees, especially in the seedling stage, will flourish under shade is a consideration of some importance in the regeneration of forests. Mr. R. S. Pearson contributes to the *Indian Forester* (April) a list of Indian trees roughly classed in five sections, according to their light-demanding requirements. Teak, *Terminalia tomentosa*, *Bassia latifolia*, and *Boswellia serrata* are noted as strong light demanders, while the ironwood tree, *Xylia dolabriformis*, *Nyctanthes arbor-tristis*, and *Aegle marmelos* are placed among the heavy shade bearers. A note appended by the editor to an article on Eucalyptus trees offers the practical hint that leaves of the blue gum and other species boiled in cylinders or boilers will be found useful in removing any hard incrustation of lime.

Opinions with regard to the limits, sources, and possibilities of Indian cottons are so widely divergent that nothing short of detailed experimental cultivation undertaken by an experienced specialist seems likely to meet with general acceptation. Mr. H. M. Leake publishes in the Journal of the Asiatic Society of Bengal (vol. iv., part i.) a short account of some experiments in the nature of an introductory note. The criterion selected is a "leaf-factor," according to which a leaf may be distinguished as narrow or broad-lobed. Crosses were made between *Gossypium arboreum* or *Gossypium neglectum* and *Gossypium indicum*. The conclusion is arrived at that plants with an intermediate leaf-factor are crosses, and other facts are cited tending to support the view that natural crosses between cotton plants do occur.

It is always a difficult matter to identify the trees that yield the timber imported from new countries. In this connection it may be said that the sources of West African mahogany have been mainly conjectural, so that it is useful to have the identifications based on the authority of Mr. H. N. Thompson, conservator of forests in northern Nigeria, that are published in the *Kew Bulletin* (No. 4). The three species *senegalensis*, *grandifolia*, and *Punchii* of the genus Khaya furnish "Benin" mahogany; similar timber from *Entandophragma Candollei*, and "Sapeli" mahogany from a species of Pseudocedrela, are also in demand. "Batum" mahogany is obtained from *Mimusops multinervis*, and a red ironwood said to resist white ant and terido worm is derived from a species of Lophira. Other trees furnish timber that is classed as mahogany, satinwood, cedar, and greenheart.

The April number of the Journal of the Gypsy Lore Society is mainly devoted to a protest against the action of the Continental Governments who are starting a crusade against vagrancy, and against the attempt in this country, under the Movable Dwellings Bill, to enforce the registration of caravans and to compel the residents in them to send their children to school. This action will, it is said, if pushed too far, drive the Gypsy into city slums, where he will suffer from ill-health and lose his national identity. At the same time, the useful chronicle in the same number of the adventures during the year 1906 of the bodies of Continental Gypsies who took refuge in this country demonstrates the necessity of bringing such people under control. It is difficult to see how any system of regulation, such as that proposed, is consistent with the maintenance of the nomadic life, a picturesque phase of our social system which few would wish to destroy.

In the Journal of the Franklin Institute (vol. clxv., No. 5) Dr. C. B. Thwing describes a new radiation pyrometer based on the measurement of the total energy of radiation by means of the current generated in a sensitive thermocouple by the radiations concentrated upon it. In the same number Mr. C. L. Huston gives the results of experiments undertaken in order to secure for practical purposes a more accurate knowledge of the interior character and structure of steel.

The Queensland Geological Survey has issued a second report (Publication No. 204) on the West Moreton (Ipswich) coalfield, with special reference to the Bundamba district. The report, which has been written by Mr. W. E. Cameron, covers thirty-seven pages, and is illustrated by two large coloured geological maps, one plate, and eight illustrations in the text. The West Moreton coalfield is at present the chief producing coalfield in Queensland, its importance being due to the generally useful character of its coal and to its proximity to the chief industrial centre and most important shipping port of the colony. The investigations described in the report show that the resources of the area under consideration will be sufficient to meet any increase likely to occur in the demand for some years.

The past week has experienced weather changes of an exceptional character. Sharp thunderstorms occurred in nearly all parts of the country. In London and the suburbs the storm experienced on June 4 was unusually severe, and was accompanied, over the southern parts of the metropolis especially, by a heavy fall of large hail and a copious downpour of rain. At Croydon the rainfall exceeded an inch in half an hour. The shade temperature in London on June 4 rose to 81°, and on the following day there was a sharp fall of the thermometer over the entire country. On Saturday, June 6, the highest temperature in London was 59°, 22° lower than two days previous. The colder weather was brought about by the setting in of a northerly wind over the whole of the British Islands, the supply of air being drawn from the neighbourhood of Iceland. On the night of June 6 the exposed thermometer fell almost to the freezing point in the south-east of England.

The frequency of different forms of clouds during the years 1903–5 is discussed in Appendix i. to the observations made at Batavia Observatory in 1905. The general results of the observations, made four times a day during the three years, show that the percentage of occurrence of cumulus was 35·3, of cirrus 21, and of strato-cumulus 11·3. With reference to the diurnal period, attention is directed to the predominance of stratus and cirrus forms and of clear sky in the morning, of the cumulus forms about noon, and of nimbus forms at the close of the day. The daily change in the amount of each cloud form is nearly the same for both dry and wet seasons, except that during the latter period (October–March) there is a greater prevalence of the nimbus forms in the morning. Also the cirro-stratus form preponderates during the wet season.

In another interesting appendix to the above-mentioned volume, Dr. W. van Bemmelen (acting director) discusses the influence of days of bright sunshine on the various meteorological elements at Batavia (1889–1906 August 1). Among the results arrived at, he finds that the clearness of the sky decreases the fluctuation of air-pressure in the early morning and emphasises it during the day; in the case of temperature, as one would naturally expect, the air is greatly cooled in the early morning and heated (to about the same degree) in the early afternoon, but the maximum is not retarded. The daily oscillation of relative humidity is strongly emphasised, especially in the wet season. The sea-breeze is much stronger, and the predominance of northerly components is much more conspicuous, but there is no evidence of a strengthening of the feeble land-breeze.

A North Wales branch of the Mathematical Association has lately been formed. Three meetings have already been held in Bangor, and have proved highly successful in stimulating discussions between those engaged in teaching mathematics in secondary and elementary schools in North Wales. The secretary of the branch is Mr. T. G. Creak, Bron Eryri, Llanberis.

Several papers on aëronautics and on meteorological experiments of aëronautical interest have reached us lately. Prof. L. Palazzo has sent a reprint from the *Bolletino della Società aeoronautica Italiana* describing the results of experiments with kites and *ballons sondes* in the Gulf of Genoa, conducted on board the torpedo-boat *Fulmine*. Prof. Cleveland Abbe has suggested somewhat original methods of studying atmospheric circulation by means of models as well as maps (Bull. Amer. Math. Soc., xiii., 10, and *Monthly Weather Review*, December, 1907). The winds in the Straits of Messina are dealt with by Dr. Filippo Eredia in the *Rivista marittima* for March.

The International Association for promoting the study of Quaternions and allied Systems of Mathematics has issued its annual report (Lancaster, Pennsylvania: New Era Printing Co., March, 1908). The president, Dr. A. Macfarlane, gives an interesting biography of his predecessor, the late Prof. Charles Casper Joly, with especial reference to his work on quaternion methods. An important feature of the report is the bibliography of recent and recently catalogued literature classified under the heads of matrices, linear substitutions, quadratic forms, bilinear forms, complex numbers, equipollences, vector analysis, commutative algebras, quaternions, biquaternions, linear associative algebras, and general algebra and operations.

Mr. E. Stanhope Kitchin, Woodford Green, Essex, writes to us directing attention to the prevailing lack of true scientific method on the part of those who are engaged in aëronautical experiments. He gives instances in which experiments have been described on air resistance of rotating planes, where the author of the paper has entirely ignored the necessity of specifying the conditions, and has failed to appreciate the difference between maintaining the torque or the power of the motor constant.

He also mentions that such statements as that the drift is proportional to the velocity, and not to its square, as demonstrated by Langley, find their way into print and are allowed to pass unchallenged. That inaccuracies such as Mr. Kitchin mentions are far too common in papers on aëronautical subjects is probably well known, with the result that the problem of flight is being worked out at the cost of a greater number of failures than would be necessary if more mathematical accuracy could be brought to bear on the work.

IN an article on the discharge of electricity through gases in the May number of the *Journal de Physique*, M. P. Villard, after a critical examination of the present view that the luminous phenomena are due to ionisation or recombination, comes to the conclusion that the opposite is the case, ionisation producing darkness rather than light. His own experiments lead him to the further result that the positive column is not an assemblage of independent particles, but an object of the nature of a vortex filament behaving like a flexible and extensible conductor, only capable of existing in gas ionised to an extent lying between certain limits, but within these limits becoming more prominent and stable as the current is increased. The arc and electric spark, according to M. Villard, are intense discharges in which the positive column plays the most important *rôle*, the negative phenomena having disappeared, while in the vacuum-tube discharge the opposite holds.

IT has been recognised for some time that when an electric discharge passes through a gas the product of the length of the spark into the pressure of the gas at which the spark passes most easily is a quantity characteristic of the particular gas used, and very nearly proportional to the mean free path of the molecules of the gas. Dr. E. Lohr, of Vienna, finds, further (*Sitzungsberichte der Wiener Akademie*, 1907, p. 1281), that the above-named product is inversely proportional to the refraction constant $n-1$ of the gas. Since the mean free path is proportional to the viscosity of the gas, Dr. Lohr draws the somewhat startling conclusion that the velocity of propagation of light in a gas is a function of the viscosity of the gas, and is, *ceteris paribus*, the greater the greater the viscosity.

So many experimenters are now interested in the accurate measurement of the alternating currents used in wireless telegraphy that it may be worth while to reproduce a portion of a table of relative sensitiveness of some of the best known of the instruments suitable for such work, given by Von Espinosa in the "Jahrbuch der drahtlosen Telegraphie," p. 328:—

| Instrument | Resistance in ohms | Watts necessary to give standard deflection |
|---|---|---|
| Hot wire air-thermometer with thin copper wire ... ... ... ... ... | 0·8 | ... $2{\cdot}5 \times 10^{-2}$ |
| Hot wire air-thermometer with thin manganin wire ... ... ... ... | 34 | ... $2{\cdot}0 \times 10^{-2}$ |
| Bolometer with iron wire in air ... | 1·8 | ... $2{\cdot}5 \times 10^{-4}$ |
| ,, ,, vacuum | 2·2 | ... $9 \times 10^{-6}$ |
| Thermo-couple of iron-eureka (Konstantan) in vacuum ... ... ... | 5·1 | ... $2 \times 10^{-4}$ |
| Duddell thermo-galvanometer ... | 18 to 100 | ... $5 \times 10^{-6}$ |

THE Board of Education is endeavouring to encourage practical work in the geography teaching of schools, and has suggested exercises of various kinds suitable for the pupils themselves to work. These exercises include a daily record of the pressure and temperature of the atmosphere the amount of rainfall, the direction of the wind, and so on. To assist teachers in securing a permanent record of these observations, Messrs. George Philip and Son, Ltd., have published a Meteorological Calendar consisting of fifty-two weekly sheets, each of which includes suitable barometer, thermometer, and rainfall tables, and a chart for recording wind direction. The calendar costs 2*s*. net, and the publishers are prepared to supply the sheets in quantity for the use of pupils. The sheets should prove useful in schools.

THE volume of "Extracts from Narrative Reports of Officers of the Survey of India" for the season 1905–6 deals, as usual, with a variety of topics. The progress made with the magnetic survey under the immediate direction of Captain R. H. Thomas, R.E., has been slower than in recent years, owing to the greater remoteness of the districts dealt with. It is hoped, however, that by the end of 1908 the "preliminary" survey will have been completed; by this apparently is meant a survey sufficient to indicate the general magnetic character of India, leaving for the future a detailed survey of any districts that may prove to be specially disturbed or otherwise of exceptional interest. A variety of magnetic information is given in tabular form, including the diurnal variation from selected "quiet" days for the observatories at Dehra Dun, Barrackpore, Kodaikanal, and Toungoo. As usual, considerable space is devoted to the comparison of instruments and their various defects. Pendulum observations were made, as previously, under the direction of Major Lenox Conyngham, R.E. To eliminate so far as possible the disturbing effects of temperature, observations were never taken, as in previous years, in a tent, but only where a house of some kind was available. Notwithstanding all precautions, irregularities still arise which it seems difficult to account for. During the year nine stations had self-recording tide gauges at work. The observations for 1905 were reduced by harmonic analysis at Dehra Dun, while full particulars of the observed values during 1904, with values of the tidal constants for 1908, were transmitted to the National Physical Laboratory, where the tidal predictor is at work. Particulars are given of the comparison of observed and predicted tidal results for 1905. Levelling operations were carried out by two parties, but call for no special remark.

THE Clarendon Press, Oxford, has published "A Chart of English Speech Sounds, with Key-words and Notes," by Mr. Daniel Jones, lecturer in phonetics at University College, London. The pronunciation of the key-words is that usually adopted by educated people in London and the neighbourhood. The price of the chart is 4*d*. net.

MESSRS. MACMILLAN AND CO., LTD., have published a third English edition of Prof. Wilhelm Ostwald's "Scientific Foundations of Analytical Chemistry treated in an Experimental Manner." The work has been translated by Dr. George M'Gowan from the fourth German edition, with further alterations and additions by Prof. Ostwald. The price of the volume is 6*s*. net.

A SALE by auction will take place in Berlin on June 20 next of scientific and mathematical manuscripts and books of the sixteenth to the eighteenth centuries. We have received a catalogue of the sale from Mr. W. Junk, Berlin W., Kurfürstendamm 201, with whom those persons unable to attend the sale, yet anxious to procure books or manuscripts, should correspond.

## OUR ASTRONOMICAL COLUMN.

BRIGHT METEOR.—Mr. Denning at Bristol saw a bright meteor of about first magnitude at 11h. 12m. on June 2 with path from 301°+50° to 265°+55°, and directed from the shower of Pegasids at 334°+28°, to which he recently directed attention in NATURE. The meteor left a streak of about 10° amongst the stars of Cygnus and Draco. At Bristol the midnight sky of June 2 was magnificent, the stars being unusually bright and the firmament remarkably dark, and comparable with some of the evenings of early autumn.

THE TOTAL SOLAR ECLIPSE OF MAY 8, 1910.—In a letter to the *Observatory*, Mr. J. F. Tennant points out the availability of Tasmania as an observing station for the eclipse of the sun due to take place on May 8, 1910. The duration of the total phase will be something like three minutes, but the sun will, at most places, apparently be at a low altitude; in fact, except at the extreme N.W., the sun sets partially eclipsed. Particulars as to times are given in the letter, and the writer states his intention to obtain particulars concerning the climatic probabilities, &c. (the *Observatory*, No. 397, p. 250, June).

THE DARK $D_3$ LINE IN THE SUN.—In the June number of the *Observatory* (p. 250) Mr. Buss returns to the discussion anent the presence of the helium absorption line in the solar spectrum. Among other things, he points out that, according to Mr. Evershed's recent letter, the position of the dark $D_3$ line is now given as being on the red side of the bright chromospheric line, whereas it was previously stated to be on the more refrangible side.

Mr. Buss adds that of 358 observing days in 1906 and 1907 he made spectroscopic observations on 317 days, and was able to detect the $D_3$ absorption on 236 days, or on about 75 per cent. of the total number. This indicates that the phenomenon of helium absorption over active solar areas is not so rare as has been thought, and Mr. Buss suggests that, with a more refined equipment than his, a practical permanency of the phenomenon over such areas, with or without spots, might be established.

It is interesting to note with regard to this that at the meeting of the British Astronomical Association held on April 29, Father Cortie expressed the opinion that for this class of work a telescope of not very large aperture and a spectroscope of moderate dispersion were required.

POSITION OF THE AXIS OF MARS.—In No. 4251 of the *Astronomische Nachrichten* (p. 39, May 29) Prof. Lowell gives the results obtained from his measures of the position of the axis of Mars during 1907. Between September 23 and December 16, 1907, 198 determinations of the position-angle of the south polar cap were made by Prof. Lowell and seventy-nine by Mr. Lampland. The measures were made in three different ways:—(1) with the micrometer thread cutting off equal segments below the cap; (2) with the thread tangent externally to the cap; and (3) with the thread tangent internally to the cap, and on collating the results it was seen that each method is subject to systematic errors. To throw some light on the question of these errors, an artificial planet was devised by Mr. Lampland on which measures were made by both observers, under conditions as far as possible identical with the true conditions. The results of these observations showed that the dichotomy measures are more trustworthy than the tangential, that they are decreased by phase, and that the tangency measures are too large.

Combining the results for the measures made during 1901–7, Prof. Lowell obtains as the general mean for the position of the axis R.A.=315° 38′, dec.=54° 39′, and for the obliquity of the Martian ecliptic 23° 8′. He then gives a table comparing his results with others obtained since 1781, and points out that there is apparently a steady decrease in the obliquity if Cerulli's observations of 1896–7 be excepted; of this phenomenon he offers no explanation.

THE ORBIT OF α ANDROMEDÆ.—From spectrograms taken at the Potsdam Observatory during the period 1901–7, Herr Ludendorff determined an orbit for the spectroscopic binary α Andromedæ, and now publishes his discussion in No. 4250 of the *Astronomische Nachrichten* (p. 23, May 21). For the period he finds 96·7 days, a value which he considers certain to within 0·1 day. In the discussion he confirms Sir Norman Lockyer's remarks as to changes in the spectrum, and records that he has on several plates observed the Mg line at λ 4481 doubled.

THE ECCENTRICITIES OF COMET ORBITS.—In No. 113, vol. xix. (pp. 67–71), of the Publications of the Astronomical Society of the Pacific, which we have just received, there is an interesting address by Prof. Leuschner on the probable general form of comet orbits. Prof. Leuschner raises strong objections against the prejudice which assumes all cometary orbits to be parabolic unless it can be proved very certainly that they are elliptic or hyperbolic. In support of his suggestion that the parabola may be the exception, and not the rule, he gives two tables, the first of which shows the percentage of parabolic orbits of comets appearing in three different periods. For the last period (1846–95) only 54 per cent. of the determined orbits had the eccentricity 1·0, and therefore it seems no more probable that a comet's path should be parabolic than that it should not. The second table classifies the orbits according to the duration of visibility of the comets, and here it appears that the longer the comet is observed the more probable it becomes that the orbit cannot be satisfied by a parabola. Of comets observed for more than 240 days, it is doubtful whether any had parabolic orbits.

## THE ROYAL OBSERVATORY, GREENWICH.

THE annual visitation by the Board of Visitors of the Royal Observatory, Greenwich, was held on Wednesday, June 3, when the customary report was presented by the Astronomer Royal dealing with the work carried out during the twelve months ending 1908 May 10. A summary of the chief points of the report is given below.

Among other matters, it is interesting to note that various national undertakings of importance were, or are being, facilitated by the loan of instruments by the observatory authorities. Thus the observers attached to the British Antarctic Expedition (1907) are using the 4-inch Simms' telescope No. 2, Captain Monro, R.N., used the transit instrument D in the determination of the longitude of Ascension, whilst a very interesting collection of historical and modern astronomical and meteorological instruments, models, photographs, &c., illustrating the past and present work of the observatory, is being exhibited in the Science Section of the Franco-British Exhibition.

Referring to the work done with the transit circle, the report states that the system of inclined wires formerly used has been replaced by a system of two close vertical wires and one horizontal wire, and the method employed for illuminating the field has been changed to that applied so successfully to the altazimuth last year. A series of observations is now being carried out in order to compare the results obtained under the respective conditions of illumination, and it is hoped that a discussion of the results may throw some light on the question of the magnitude equation in the observation of the fainter stars.

The transit was employed for the usual observations of the sun, moon, planets, and fundamental stars, the working list being made up by the inclusion of stars of the ninth magnitude and brighter between the parallels of north declination +24° to +32°, which will serve as reference stars for the Oxford astrographic zones. Eight thousand seven hundred and twenty-three transits and 7960 circle observations were taken during the year.

From the observations made in 1905, applying Bessel's refractions, 38° 31′ 21″·70 was determined as the co-latitude, whilst those made in 1906, with Pulkowa refractions, gave the value 38° 31′ 21″·67. The reduced solar observations of 1906 show the correction to the tabular values for the obliquity of the ecliptic to be −0″·09, and the observations of the summer and winter solstices indicate that the mean of the observed distances from the pole to the ecliptic is apparently 0″·005 too great.

Each day, when practicable, three or more observations of level and nadir were made, and it was found that the diurnal changes of level ranged from +0″·13 at noon, to 0″·00 at 6 p.m., to +0″·18 at midnight; the corresponding values for the nadir were found to be +0″·17, 0″·00, and

$+0''.14$. The mean error of the moon's tabular place, determined from eighty-two observations and computed from Hansen's tables with Newcomb's corrections, was $-0.383$s. in R.A. and $+0''.15$ in N.P.D. for 1906. From 104 observations in 1907 the error is $-0.401$s. in R.A.

Part i. of the Second Nine-year Catalogue, epoch 1900, dealing with fundamental and zodiacal stars, is already in the printer's hands, and part ii., giving the astrographic reference stars, will be ready for the press shortly.

The new method of illuminating the altazimuth field, as described in the previous report, has proved very satisfactory, and has now been adapted to the transit instrument. The altazimuth was used for meridian and extra-meridian observations throughout the year, and the observations of the lunar crater Mösting A, commenced in 1905, were continued whenever practicable; these serve to connect the observations of the first and second limbs made before and after full moon, and, when discussed with the similar observations that are being made at the Cape Observatory, will provide data for the determination of the lunar parallax. Forty-three observations of the N.P.D. and of the R.A. of the crater were made during the year. That both the transit-circle and altazimuth observations are satisfactory is shown by their agreement.

From the altazimuth observations in 1907 the mean errors of the moon's tabular place are:—moon's limb, in meridian, $-0.36$s.; Mösting A, in meridian, $-0.35$s., moon's limb, extra meridian, $-0.42$s.

The larger scheme of reflex-tube observations, mentioned in the preceding report, was prosecuted throughout the year, 1545 double and forty-four single observations being made; the total number of stars observed, including $\beta$ and $\gamma$ Draconis and $i^2$ Cygni, which are observed throughout the year, was eighty-five. With the view of determining the variation of latitude, the discussion of the observations from 1903 onwards has been commenced, but owing to the variation of the instrument's scale value from night to night, caused by minute alterations in the distance between the mercury surface and the object-glass, there are serious difficulties to be overcome in the discussion. This distance can be adjusted to within about 0.01 inch by means of the focussing rod, but an error of that amount would introduce errors quite inadmissible in the deduced zenith distances of the stars at a distance from the centre of the field. For example, in the case of $\beta$ Draconis, which is $53\frac{1}{2}'$ from the zenith, the error would amount to $\pm 0''.56$.

The 28-inch refractor was employed for observing double stars, primarily those pairs discovered by Mr. Hough, and measures were made on 105 nights as compared with eighty-six nights last year; $\kappa$ Pegasi was measured on fifteen, $\delta$ Equueli on thirteen, and 70 Ophiuchi on sixteen nights. Complete sets of measures of the polar and equatorial diameters of Jupiter were made, first with the filar and then with the double-image micrometer, on seventeen nights, whilst with the filar micrometer the diameters of the satellites were determined on two nights.

It was mentioned in the last report that a system of twelve lignum-vitæ wedges had been employed to fix rigidly the mirror of the 30-inch Thompson reflector. Whilst the method has proved very satisfactory in fixing the mirror, there is a tendency to produce slight distortion, so it is proposed to introduce a further modification of the support the next time the mirror is dismounted for re-silvering. Cast-iron blocks, shaped to fit the steel supporting band round the edge of the mirror, are to be introduced, the pressure being applied by screws passing through the cell; in this way the strain may be adjusted as required.

Thirty-one photographs of Neptune and its satellite were secured with the 26-inch refractor, using the occulting shutter as in previous oppositions, on sixteen nights; photographs of Saturn's, and of Jupiter's distant, satellites were also taken. In regard to the latter, Mr. Melotte and the Greenwich observers generally are to be heartily congratulated upon the discovery of Jupiter's eighth satellite, first noted on a photograph taken on February 28. Altogether twelve photographs showing this object were secured between January 27 and April 24, and the measurements show that the newly discovered satellite is very much more distant from Jupiter than the sixth and seventh satellites, and is perhaps not quite so faint as the seventh. Of J. vi. and vii., respectively, thirty-eight and twenty-two photographs were secured during the opposition.

The 30-inch reflector was also used to photograph fifty-four minor planets, and comets 1907*d* and *e*. Several long exposures on comet 1907*d* (Daniel) produced negatives in which the structure of the tail is of great interest. Four long exposures were made in an unsuccessful search for Halley's comet, and this search, for which an ephemeris, based on the perturbations calculated at Greenwich, has been prepared, will be resumed during the coming autumn.

With the astrographic equatorial, 128 satisfactory plates were taken during the year to replace plates which, although satisfactory in other respects, are unsuitable for reproduction of large prints. Positives have been made and passed for 192 plates which cover the zones $75^\circ-78^\circ$, and 109 plates in zones between $79^\circ$ and the pole. Only fifteen chart plates remain for reproduction, and these have to be replaced by more suitable negatives.

The work of the Greenwich section of the Astrographic Catalogue is complete so far as the publication of the measured rectangular coordinates and the data necessary to convert them into Right Ascension and Declination is concerned. The conversion of the coordinates of such stars as are in Carrington's Catalogue has been commenced. Vol. ii. of the Greenwich Astrographic Catalogue was published during the year, and contains 98,738 stars. The report contains an interesting table, too large to reproduce here, comparing the number of stars which appear on the plates for each zone and for the three different exposures, and also comparing these numbers with the number of stars shown in the same zones of the Bonn Durchmusterung; the total number of stars shown on the forty-minutes' plates is 719,088, or 344.4 per square degree.

The perturbations of Halley's comet, which are being computed by Messrs. Cowell and Crommelin, and the data necessary for determining the time of next perihelion passage, are nearly complete, but some further investigation of the close approaches of the comet to Jupiter in 1834 and 1837, when the perturbations appear to have been considerable, is necessary; 1910 April 8 appears to be the most probable date for the occurrence of the next perihelion passage. Mr. Crommelin has confirmed Dr. Hind's identifications of the comet with three exceptions (1223, 912, and 837), and the perturbations have been carried back to 760.

Photographs of the sun were taken with the Thompson photoheliograph on 210 days, and with the Dallmeyer photoheliograph alone on two days.

Some remarkable fluctuations of the solar activity during 1907 are reported. From July onwards an increased activity occurred, and several naked-eye groups were observed.

The usual magnetic observations were carried out during the year, and the principal results for the magnetic elements for 1907 are given as follows:—

| | |
|---|---|
| Mean declination ... ... | $15^\circ$ $59'.8$ West |
| Mean horizontal force ... | 4.0195 (in British units)<br>1.8533 (in metric units) |
| Mean dip (with 3-in. needles), | $66^\circ$ $56'$ $4''$ |

In 1907 there was one day of great magnetic disturbance and sixteen of lesser disturbance.

The meteorological results show that the summer of 1907 was exceptionally windy, and that the mean temperature of the year was $49^\circ.4$, or $0^\circ.2$ below the average of the sixty-five years 1841–1905. The rainfall of the year ending 1908 April 30 was 23.14 inches, being 0.98 inch below the sixty-five-year average.

The testing of chronometers and chronometer watches showed a serious falling off in the performance of the former and an improvement in that of the latter instruments.

The danger which threatened the observatory from the working of the L.C.C. generating station on the northern meridian has been averted to a great extent by the two years' working agreement with the Council. Apparently the close, double-star observations with the 28-inch refractor are not affected prejudicially, but it is still desirable that the trouble arising from the outflow of heated gases, which interfere with the observation of northern stars on the meridian, should be mitigated.

## VISUAL ILLUSION AND FIXATION.

A REMARKABLE new visual illusion is described by Dr. James Fraser in the *Journal of Psychology* for January. In the first form of the illusion a word (such as "LIFE") is printed in capital letters on a chequered background of black, grey, and white squares. The double outline of the letters is not traced in continuous lines, but is constituted by a band consisting of short lines, alternately black and white, slightly inclined to the direction of the limbs of the letter. This band may conveniently be regarded as representing a cord made of two strands, black and white, twisted together. In these circumstances the letters appear, in general, to be inclined several degrees from their actual directions, the sense of the deviation varying with the direction of the constituent lines of the

Fig. 1.

illusory band (see Fig. 1). A number of figures are given illustrating variants of this form of the illusion, and facilitating a study of the limits within which it persists.

In a second form of the experiment concentric circles or ellipses made of the "twisted cord," and laid upon a chequered surface of peculiar construction, are shown to suffer apparent distortion of an extraordinary character (see Fig. 2).

The paper (which is excellently illustrated) concludes with a short discussion in which the author points out the factors which appear to him to determine the presence and disappearance of the illusion.

Fig. 2.

[1]Upright letters of appropriate size and concentric circles of appropriate diameter, drawn on tracing paper and superimposed upon the figures, will demonstrate the character of the illusion in each case.

The *Psychological Review* has published, as a monograph supplement (November, 1907), an account of an experimental study of visual fixation conducted by Prof. Raymond Dodge in the psychological laboratories of Wesleyan University. The main result of this careful and interesting work is to render untenable the traditional assumption of an identical anatomical and functional centre of the retina, to which all visual processes are referred or referable. Prof. Dodge shows (following, in part, Delabarre and McAllister) that during supposed fixation there is continuous movement of the point of regard over a variable area of appreciable extent. This is the result of uncompensated disturbances produced by the pulse and respiration, and by irregular head and body movements. On the other hand, the investigation has brought to light a number of eye-movements compensatory of movements of head and trunk, the perfection of which (since the reaction time of the eye is relatively slow) points to the existence of highly organised motor systems embracing both ocular and somatic muscles. The discovery that there is, strictly, not a fixation point, but merely a fixation area, renders improbable the current hypothesis that assumes a tendency to transfer every peripheral stimulus to the centre of the fovea. Actual experiment shows, in fact, that when a given word is read the point of regard may rest indifferently in many situations. These observations have, obviously, an important bearing upon the question of retinal space-perception, and Prof. Dodge uses them to discredit the theory that the motor-impulse by which a peripheral object of regard would be brought to a supposed constant intra-foveal fixation point is a "local sign" differentiating the retinal point stimulated from every other. He proposes to substitute for it the conception of a differentiated organisation of the retinal groups, and shows how such an organisation might be brought about by the agency of the fixation movements.

## SOME RECENT PETROLOGICAL PAPERS.

A DETAILED study of the granite of Brixen has been contributed by Herr Bruno Sander to the *Jahrbuch der k.k. geologischen Reichsanstalt*, vol. lvi. (1906), p. 707, which involves many interesting questions of the intimate penetration of sediments by igneous rocks, and directs fresh attention to the marginal facies known as tonalite-gneiss (pp. 726–34). The author shows that a foliated structure existed in this rock before deformation by pressure occurred. Dr. Trener, on the other hand (*ibid.*, pp. 415 and 458), in a paper on the Presanella group, containing many petrographic details, treats tonalite-gneiss as a product of pressure, and the basic inclusions in it as segregations. One of Sander's most suggestive observations is the finding of amphibolites, closely resembling the tonalite-gneiss, in the old limestone series that has been invaded by the granite; and he is led to ask (p. 734) whether the occurrence of tonalite-gneiss does not in some way depend on the horizon selected by the granite for its intrusion continuously from Meran to Mauls.

Dr. Trener's paper, just referred to, contains (p. 484) a valuable appendix on graphite, in which Luzi's "graphitite" and Sauer's "graphitoid"—a graphite in metamorphic rocks—are both opposed as mineral species.

Mr. Joseph Barrell's "Geology of the Marysville Mining District, Montana" (U.S. Geological Survey, Prof. Paper No. 57, 1907) is also "a study of igneous intrusion and contact metamorphism," dealing particularly with a great batholithic inflow of granite among pre-Cambrian strata at the opening of Cainozoic times. Various igneous rocks, from gabbros to aplites, appear as subsidiary intrusions. The contact-phenomena have been studied to advantage in mine-sections down as far as 1300 feet. A strong case is made out for the occurrence of "stoping," by the falling in of blocks "10 to 200 feet or more in thickness and of considerably greater length" (p. 172), and the consequent rise of the granite into its former cover of Algonkian rocks.

Mr. R. A. Daly, another strong advocate of "stoping," in a paper on the Okanagan composite batholith of the Cascade Mountain system (Bull. Geol. Soc. America, vol. xvii., 1906, p. 329), urges that this batholith actually replaces an equal or approximately equal mass of the older solid rock. Those of us who have been maintaining this somewhat natural view from field-observations on batholiths in our own islands must join with Mr. Daly in hail-ing its growing acceptance, though many will still hesitate before his conclusions (p. 373) as to the profound modification of a gabbro-magma by absorption of pre-existing acid masses. He admits, with other writers, a "gravitative differentiation of the compound magma of assimilation," and urges that at each stage in the intrusion of the Okanagan batholith a magma more basic than the average of the rock invaded became enriched with silica by assimilation, and also by this gravitational draining away of the denser material. Dynamic and accompanying hydrothermal actions are said to have produced gneisses from the intrusive Okanagan "granodiorite," and it is held that in many places mineral material, especially from the more basic constituents, "has been leached out from the granulated rock and has re-crystallised in strong shear zones to which the solutions have slowly travelled" (compare pp. 345–6). This would seem in accord with Lehmann's view of the development of biotite along shear zones; and, as even a tentative explanation of the formation of a strikingly banded gneiss out of a homogeneous "granodiorite," it has considerable petrographic interest.

Messrs. E. C. Andrews and J. C. H. Mingaye, assisted by the careful petrographic descriptions of Mr. G. W. Card, discuss the granites of northern New England in part iv. of their description of the New England plateau of New South Wales (Records Geol. Survey N.S.W., vol. viii., 1907, p. 196). They conclude that their granitic masses are mostly "bathyliths." At Hillgrove they find a diorite (p. 232) that passes insensibly through a fine-grained granite rich in biotite into silicified slates, which further pass into true black slates. "The biotite-granite is thus possibly a compromise between the slates and the diorite." The authors urge (pp. 234 and 237) that the "bathyliths" have occupied their present positions at the expense of the older rocks, and they are advocates of stoping as a means of carrying away derived material. In part v. of the memoir (*ibid.*, p. 239), Mr. Andrews explains the structure of the deposits of wolfram, cassiterite, and molybdenite as a "replacement of granite by [the products of] solutions and gases rising along the intersecting joints" (p. 241), and spreading at times from "an incredibly small core." Mr. Card contributes "Mineralogical and Petrographical Notes, No. 10" (*ibid.*, p. 257), referring his rocks to the American system of classification, on the basis of the thorough analyses provided by Mr. Mingaye's laboratory. We hope that some day these notes may be brought together into a general petrographic study of the colony, so that we may learn the part that each rock has played in the broad sequence of geological events.

A fine example of that rare rock, orbicular granite, is described from the Transvaal Bushveld by Mr. W. J. Gau (Trans. Geol. Soc. of S. Africa, vol. ix., 1906, p. 70).

The mining district of Pitkäranta on Lake Ladoga, in Finland, has been thoroughly investigated by Mr. Otto Trüstedt from a mineral and petrographic point of view (*Bull. de la Comm. géol. de Finlande*, No. 19, 1907). His fine memoir, written in German, of more than 300 pages, lays special stress on three zones of "skarn"—a somewhat forbidding word in Swedish—which here means a calciphyre formed from crystalline and usually dolomitic limestones. These limestones are part of an ancient amphibolitic and sedimentary series, now highly metamorphosed, into which granites and pegmatites intruded in early pre-Cambrian times, followed in much later, but still pre-Cambrian, times by the great mass of Rappakiwi-granite. The "skarn," chiefly composed of salite and garnet, is believed (p. 91) to have arisen through the influence of magmatic waters circulating from the earlier intrusive bodies. Earth-movements then broke it up in many places into blocks, round which singular modifications have taken place. Serpentinisation, acting through a long period, has spread inward from their surfaces (*e.g.* pp. 218 and 235), producing an eozoönal structure, built up of salite, serpentine, and calcite. This banded structure is well shown in the photographic plates and figures. The Rappakiwi-granite ultimately invaded the whole series of rocks, and became solid. During the last phases of the eruptive activities of which it forms the climax, metallic ores, including cassiterite, were deposited in its zone of contact. Magnetite, zinc-blende, and sulphides of iron and copper now began to replace certain layers of the "eozoön," and the outer portions of some of the lumps of "skarn," or "Salitaugen," pass into pure ore. Even garnets (p. 138) have been dissolved away along certain of their zones of growth, and these zones have been replaced by metallic minerals. The author agrees with Vogt (p. 315) that the Pitkäranta ore-deposits belong to the true contact-metamorphic type, and occupy a middle position between the iron and copper deposits of Christiania and the tin and copper deposits of Cornwall.

Mr. Curt Fircks's paper, written in English, on the occurrence of gold in Finnish Lapland (*ibid.*, No. 17, 1906), describes ferruginous veins traversing granulite as the mother-lodes of the alluvial gold; but it is not clear why they are called (p. 33) "a new type of gold veins, not yet observed in other parts of the world."

Messrs. Johnson and Warren (American Journal of Science, vol. xxv., 1908, p. 1) revive our interest in Wadsworth's "cumberlandite" in their account of the geology of Rhode Island. This rock becomes a "rhodose" in accordance with the new system of classification (p. 25); it has the high specific gravity of 4, owing to its groundmass of inter-grown magnetite and ilmenite, enclosing hyalosiderite (p. 19), an olivine rich in iron. The olivine has retained grains of the iron ore within it, and Mr. Warren suggests that these were prevented from joining the main mass by the decreasing mobility of the separating olivine, and he favours the supposition that the minerals became immiscible before their freezing point was reached (p. 22).

An unusual group of rocks, for which ultra-basic intrusive masses seem primarily responsible, is described from the Vizagapatam district of Madras by Messrs. T. L. Walker and W. H. Collins (Records Geol. Survey of India, vol. xxxvi., 1907, p. 1). The ultra-basic igneous border of a mass of granulites and garnetiferous granites (charnockite series) is believed to have mingled with sillimanite-schists. Rocks rich in green spinel and magnetite thus pass into others where the spinel is largely replaced by sapphirine, and sapphirine is regarded (p. 11) as a product of the interaction of spinel and sillimanite. A mineral hitherto described as hypersthene in the charnockite series, with a pleochroism "sky-blue to red or red-brown" (p. 14), is shown to have frequently oblique extinction. The authors seem to throw doubt on the existence of "a rhombic pyroxene with the properties usually assigned to hypersthene"; but surely they mean merely to ask whether rhombic pyroxene ever has a "sky-blue" axis-colour.

Before leaving ultra-basic igneous rocks, it may be mentioned that Dr. Corstorphine further defends his view, criticised in South Africa and elsewhere, as to the concretionary nature of the eclogite masses in the diamond-pipes of Kimberley (Proc. Geol. Soc. of S. Africa, 1907, p. lxi). The tenth volume of the Transactions of the Geological Society of South Africa, which these Proceedings accompany, contains contributions by Messrs. Voit, Merensky, and J. P. Johnson on the same subject, and an interesting rejoinder by Prof. T. G. Bonney to Messrs. Corstorphine and Voit, all being included in the part for July to December, 1907.

Mr. L. L. Fermor, in describing rhyolites and basalts from Pávágad Hill, Bombay Presidency (*ibid.*, vol. xxxiv., 1906, p. 148), points out differences between the former and the Maláni rhyolites of Rájputana described by Mr. La Touche, in spite of some points of striking resemblance. In consequence, he is able to suggest that the Pávágad rocks, both basic and acid, were poured out as differentiation-products from one caldron in Cretaceous times, the alternative being that the basalts form intrusive sills in a far older rhyolitic series. A vertical section of 2400 feet of rock is exposed, to which Mr. Fermor invites the attention of future visitors who can undertake its detailed exploration.

From five weeks' study in the field, Mr. James Currie has drawn up an illustrated list, arranged topographically, of the minerals in the basaltic Færöes, which will especially appeal to students of zeolites (Trans. Edinburgh Geol. Soc., vol. ix., 1906, p. 1).

Coming now to sedimentary deposits, Herr Meigen has continued his researches on calcium carbonate, which have been so practically fruitful (*Ber. naturforsch. Gesell. zu Freiburg i. Br.*, Bd. xv., 1907, pp. 38–74). His precipitates of aragonite globules or needles from various solutions pass for the most part into calcite, with characteristic rhombohedral forms, in periods varying from twenty-four hours to three months. A few, from dilute hot solutions, remain unaltered, at any rate for the period of observation, which in one case is as long as four months. Experiments to determine the composition of the coloured deposits produced by the action of calcium carbonate on salts of cobalt showed (p. 57) that calcite assumes a violet colour *when in the form of an impalpable powder* and treated in a distinct[illegible]e solution of cobalt nitrate. Ordinary fragments remain uncoloured, or become blue on continued boiling in a concentrated solution, while aragonite under all conditions becomes, as is now well known, violet. Though the violet colour arises in powdered calcite more slowly than in aragonite, this new discovery serves as a warning to be regarded in the application of Meigen's test. The author determines (p. 74) the violet precipitate on aragonite from a concentrated solution of cobalt nitrate as $2CoCO_3 + 3Co(OH)_2 + H_2O$, and the blue one on calcite as $CoCO_3 + 3Co(OH)_2$.

Prof. R. B. Young, in describing the calcareous rocks of Griqualand West (Trans. Geol. Soc. of S. Africa, vol. ix., 1906, p. 50), shows how oolitic dolomites have been converted into granular quartzites, and supports the late Mr. Rutley's views as to the origin of certain "metasomatic quartzites." Mr. G. Abbott illustrates many of the well-known forms of concretion in the Durham dolomite in a general paper on concretions (Trans. South-Eastern Union of Sci. Societies, 1907).

Messrs. T. M. Reade and Philip Holland continue their researches on our much-neglected sedimentary rocks with the analysis and discussion of a series collected near Ludlow. A full analysis of the Titterstone Clee dolerite is also given (Proc. Liverpool Geol. Soc., 1907).

Lastly, Mr. R. A. Daly's paper on the limeless ocean of pre-Cambrian time (Amer. Journ. Sci., vol. xxiii., 1907, p. 93) raises many important questions as to the mode of origin of pre-Cambrian sedimentary rocks. The author holds that the land-areas of Eozoic times were of insufficient extent to supply enough lime to the ocean for the demands of shell-forming organisms. The continuous decay of abundant soft-bodied animals precipitated, moreover, as calcium carbonate what little lime entered the seas; the magnesian limestones so frequently found in pre-Cambrian sediments were also deposited as inorganic rocks by the prolonged action of the ammonium carbonate after the lime salts had been dealt with. It was only when, in Cambrian times, land-areas became more pronounced that shell-forming animals could become common; hence the rather abrupt transition from beds almost devoid of fossils to those with an abundant fauna. All this gives the reader food for meditation, and brings the petrographer, as is fitting, into the field of evolutionary geology.

G. A. J. C.

## THE INSTITUTION OF MINING ENGINEERS.

THE forty-eighth general meeting of the Institution of Mining Engineers was held on June 4 and 5 in London in the rooms of the Geological Society. Mr. C. E. Rhodes read his presidential address, in which he stated that steps were being taken to transfer the headquarters of the institution to London. The main portion of his address was devoted to a consideration of some of the problems with which the rising generation of mining engineers will have to deal, namely, the sinking of deep shafts through water-bearing strata, the depth to which tubbing can be put in, improved methods of splitting the air which will be required at great depths for cooling down the working places, and the method of dealing with dust, which in all probability will be abundant in deep mines.

The first paper read described the mineral resources of Trinidad. The author, Mr. John Cadman, gave a brief account of the gold ore, iron ore, graphitic schist, limestone, and coal known to exist, and dwelt more fully upon the bituminous minerals, which are of great economic importance. In a mine of the bitumen known as manjak an explosion occurred in 1904, causing the death of seventeen miners. A sample of gas examined by the author contained 14·00 per cent. of oxygen, 11·10 per cent. of carburetted hydrogen, 1·60 per cent. of hydrogen, and 73·30 per cent. of nitrogen. It is suggested that the deficiency in oxygen is due to the absorptive properties of the manjak. During the meeting several other papers of scientific interest were read. Mr. J. B. Tyrrell described the recently discovered mineral veins of cobalt in Ontario. Mr. Greville Jones gave an account of the various types of calcining kilns for iron ore. Mr. C. B. Wedd and Mr. G. C. Drabble described the occurrence of fluor-spar in Derbyshire. The longest paper read was by Mr. S. L. Thacker, on winding-engine tests. He recorded the results of his own experience, pointed out some sources of loss, and suggested the lines on which winding-engine tests should be carried out.

In connection with the meeting, excursions were arranged on June 4 to a diving demonstration at Lambeth under the supervision of Dr. J. S. Haldane, on June 5 to the mining and metallurgical section of the Franco-British Exhibition under the guidance of Mr. Bennett H. Brough, and on June 6 to the South Metropolitan Gas Company's tar works. A new self-contained diving apparatus suitable for work in mines was exhibited for the first time. The supply of oxygen is automatic, and is furnished to the diver mixed with 60 per cent. of air. At the Franco-British Exhibition Sir Hugh Bell received the visitors in the Machinery Hall, and gave an account of the collective pig-iron exhibit and the other objects of interest in the iron and steel section. The French mining section, in which the scientific aspects of working are well shown, was much appreciated.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—On Monday, June 8, Mr. William Bateson, F.R.S., was elected to the chair of biology, which has been established for five years largely owing to the generosity of an anonymous benefactor. Mr. Bateson, who was born in 1861, is a son of the late Rev. W. H. Bateson, D.D., Master of St. John's College, and has been a fellow at the same foundation since 1885. He was educated at Rugby School, and held the Balfour studentship from 1887 to 1890; for many years he has been one of the leading workers in England on heredity and variation, and has published several important treatises on these subjects. In 1904 he received the Darwin medal of the Royal Society.

Mr. A. R. Hinks has been re-appointed chief assistant of the observatory for a period of five years from June 24, and Mr. W. E. Hartley has been re-appointed an assistant of the observatory for a period of five years from July 13.

Prof. Thomson gives notice that the new building of the Cavendish Laboratory will be opened by the Chancellor on Tuesday, June 16, at 4 p.m. In consequence of the limited accommodation, admission will be by ticket only.

In the forty-second annual report the museums and lecture-rooms syndicate records a gift of 500*l.*, made by Mr. Frank Smart, for the purchase of additional furniture and fittings in the museum of botany. The library in the department of physiology has been materially increased by many books formerly in the possession of Sir Michael Foster; the library of the medical school has also received many additions, including a large number of pamphlets and books presented by Sir T. Clifford Allbutt, K.C.B. The Woodwardian professor records several important additions to the museum, especially a fine series of slates, marbles, and rocks of economic value, which have been presented by Mrs. J. F. Walker, of York. The syndics' accounts for the year show a balance in favour of the maintenance fund of 33*0l.* 4*s.* 4*d.*

The prize of 50*l.* out of the Gordon-Wigan fund for a research in chemistry has been awarded to Mr. L. A. Levy for his research entitled "Investigations on the Fluorescence of Platinocyanides."

Notice is given that a prize of 50*l.* out of the Gordon-Wigan fund will be awarded at the end of the Easter term, 1909, for a research in chemistry, of sufficient merit, carried out in the University. The research may be in any branch of chemistry. The dissertation, with the details of the research, must be sent to the professor of chemistry not later than the division of the Easter term, 1909.

Liverpool.—At the graduation ceremony on July 11 the honorary degree of LL.D. will be conferred upon Sir John Brunner, Principal Macalister, and Prof. Vinogradoff; of D.Sc. upon Mr. Francis Darwin and Prof. J. L. Todd; and of D.Eng. upon the Hon. C. A. Parsons.

Manchester.—On the occasion of the installation of Viscount Morley of Blackburn as Chancellor of the University, on July 9, the honorary degree of Litt.D. will be conferred upon Mr. A. J. Evans, F.R.S., of D.Sc. upon Prof. Baldwin Spencer, F.R.S., and Prof. A. Gamgee, F.R.S., and of M.A. upon Mr. William Burton, for his scientific investigations and art productions in pottery. H.M. Treasury has allowed the grant of 12,000*l.* to remain at that figure for another year instead of reducing it to 10,000*l.* It is hoped that the grant will be continued on the higher basis, and possibly increased.

Oxford.—Dr. B. P. Grenfell has been appointed extraordinary professor of papyrology.

The Rolleston memorial prize for 1908 has been awarded to Mr. C. C. Dobell, Trinity College, Cambridge; Mr. W. K. Spencer and Mr. C. H. G. Martin, B.A., both of Magdalen College, Oxford, were honourably mentioned by the examiners.

The Romanes lecture for 1908 will be delivered by Canon Scott Holland in the Sheldonian Theatre on Saturday, June 13, at 5 p.m. The subject of the lecture is "Bishop Butler."

The Robert Boyle lecture was delivered by Prof. Rutherford on Friday, June 5, in Balliol College Hall, the subject of the lecture being "The Transformation of Radio-active Matter."

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A conversazione will be held at the East London College (University of London) on Wednesday next, June 17. The college departments will be open from 8 to 9.30 p.m.

A Shaw studentship for research, the gift of Mrs. Bernard Shaw, of the value of 100*l.* a year for two years, will be awarded in July by open competition at the London School of Economics and Political Science, Clare Market, W.C. Particulars of the scholarship can be obtained from the director of the school.

The Bill "to make further provision with respect to the University of Durham" has now been printed. It proposes to appoint a body styled the University of Durham Commissioners. These Commissioners are to hold office until the end of 1909, but their powers may be continued by the King in Council, but not beyond the end of 1911. Their powers are to make statutes regulating the constitution of the University and the powers and duties of its authorities and constituent bodies and the disposition of its property in accordance with a scheme scheduled as an appendix to the Bill. Provision is made for the affiliation to the University in the faculty of science of the Sunderland Technical College, subject to its satisfying the conditions specified by the Senate of the University. The Senate is to consist of thirty-seven persons, namely, the Chancellor, six persons nominated by the Crown, the Dean and Chapter of Durham, together with so many other persons appointed by the council of the Durham colleges as shall make six in all, six appointed by such professors, tutors, and lecturers of the Durham division of the University as are not members of the Chapter, four appointed by the College of Medicine, Newcastle, four by the council of Armstrong College, and four by the professors of Armstrong College, and six appointed by Convocation, three being past students of the Durham division and three past students of the Newcastle division. Full powers are assigned to the Senate over the property, conditions of study, examinations, and degrees of the University. The Newcastle division of the University is to consist of the University College of Medicine and Armstrong College, Newcastle, but no council is set up for this division.

The twenty-eighth annual report of the council of the City and Guilds of London Institute, dealing with the work of 1907, has now been published. The reports of the dean of the Central Technical College, of the principal of the Finsbury Technical College, of the South London Technical Art School, and of the department of technology constitute important appendices. The total income of the institute for 1907 amounted to 46,036*l.*, as compared with 44,848*l.* in 1906. A table showing the amount of the donations and subscriptions to the funds of the institute since its foundation provides much interesting information. In 1878 the total amount of such donations and subscriptions was 12,102*l.*, while in 1907 the amount reached 22,343*l.*, a gratifying increase of more than 10,000*l.* Since its foundation the institute has received from this source the large sum of 778,365*l.*, to which the table shows there have been fifty-three contributors. The largest total benefactions received in the period mentioned are from the Goldsmiths' Company, 135,314*l.*; the Fishmongers' Company, 112,270*l.*; the Clothworkers' Company, 111,750*l.*; the Mercers' Company, 75,000*l.*; the Drapers' Company, 51,500*l.*; the Skinners' Company, 50,862*l.* Previous reports of the council have directed attention to causes which impede progress in the technical instruction of artisans, and in the report on the department of technology this year the matter is referred to again. The impediments which continue to exist are, first, the difficulty of finding competent teachers, and, secondly, the unduly large proportion of artisan students who enter technical classes without the preliminary knowledge necessary to take full advantage of the instruction they receive. We have referred on many occasions in these columns to the necessity for serious continuation-school work after the elementary school has been left if young artisans are to derive full benefit from technical courses later in life. It is quite clear that the gap between the day school and the technical institute must be bridged in some way if the money expended on technical instruction is to produce its best results.

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## SOCIETIES AND ACADEMIES.

### London.

**Royal Society**, March 26.—"Note on the Ascent of Meteorological Balloons and the Temperature of the Upper Air." By **A. Mallock**, F.R.S.

The recent investigation of the upper atmosphere by means of india-rubber balloons has led to the discovery that an almost constant temperature is reached when the pressure has decreased to about 150 mm. The lowest pressure reached in England is a little under 50 mm., and the corresponding height about 20 kilometres.

The note examines from a theoretical point of view what the behaviour of balloons such as are used in meteorological work must be as regards the possible heights to which they might ascend and the variations of their velocity as they rise. The determining factors are:—

(1) The relative density of the gas in the balloon and of the outer air at the same pressure.

(2) The ratio of the dead weight of the balloon and fittings to the total lifting force at ground-level.

(3) The compression, by the elasticity of the balloon, of the gas it contains.

It is shown that the velocity of the balloon at first increases as the one-sixth power of the ratio of the density of the air at the elevation attained to the density at ground-level,[1] and that when the elastic compression is small the upward velocity reaches its maximum not far from the greatest elevation to which the balloon can attain.

The results of the equations are traced in Diagram I., the values for the ratio of dead weight to lifting force and the elastic compression being such as are likely to be met with in practice. It is remarkable how rapidly the velocity decreases as the minimum pressure is approached.

To connect the pressure with the height at which it is experienced, the temperature at every point of the ascent

[1] The reason being that the decrease in density rather more than compensates for the effect of the increased cross-section.

must be known, and this information is furnished by the automatic recorder attached to the balloon.

A comparison is made between the actual temperatures and the adiabatic temperatures, *i.e.* the temperature which a given volume of dry air would have if transported from ground-level to a given height and allowed to expand without receiving or losing heat.

The height at which the pressure $p$ is found in these circumstances is (if H = height of homogeneous atmosphere) $h = \mathrm{H}\frac{\gamma}{\gamma-1}\left(1 - m^{-\frac{\gamma-1}{\gamma}}\right)$. (where $m = p/p_0$), which gives a finite limit to the height of the atmosphere at 27 kilometres nearly. The ratio of the absolute temperatures at $p$ and $p_0$ is $\theta/\theta_0(1/m)^{\frac{\gamma-1}{\gamma}}$.

For isothermal expansion $dh = d\mathrm{H}p_0/p$, and if the arbitrary relation between temperature and pressure found from the balloon records is $\theta/\theta_0 = \phi(p)$, the actual value of

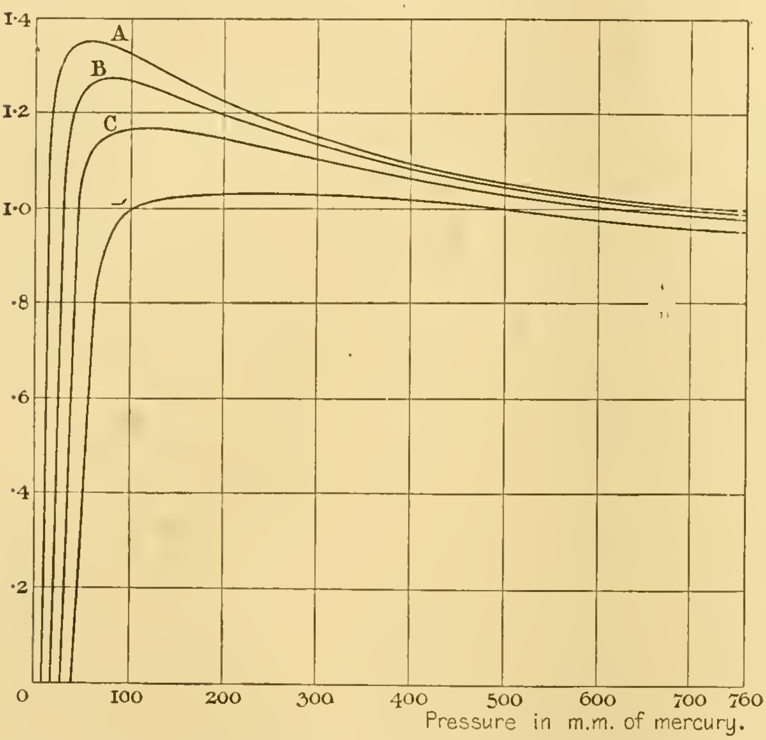



DIAGRAM I.—Velocity of ascent of balloons. The ordinates give the ratio of the velocity of a balloon in air at pressure $p$, carrying a load 0·6 $F_0$, and with internal pressure $= p + \frac{p_0}{n}\left(\frac{p_0}{n}\right.$ being the elastic compression and $F_0$ the total lifting force at ground level), to the velocity at $p_0$ of the same balloon if devoid of weight, and with the external and internal pressures equal. For A, $n = 100$; for B, C, and D respectively $n = 75$, 50, and 30.

$dh$ is $d\mathrm{H}\phi(p)p_0/p$, the integral of which can readily be found graphically.

The relations of the height corresponding to a given pressure on the supposition of (1) constant temperature, (2) temperature as observed, (3) adiabatic temperature are given, and it is noted that the observed decrement of temperature is almost exactly 0·7 time the adiabatic decrement down to a pressure of rather less than 200 mm., corresponding to a height of 11 kilometres.

Heights approaching 40 kilometres could probably be reached if the balloons were made more expansible, *i.e.* if the unfilled balloons were of thinner material and larger in volume than those at present in use, as this would allow of the same lifting force for the given quantity of gas and give more scope for expansion with diminished pressure.

Geological Society, May 20.—Prof. W. J. Sollas, F.R.S., president, in the chair.—Some fossil fishes discovered by Prof. Ennes de Souza in the Cretaceous formation at Ilhéos, State of Bahia (Brazil): A. S. **Woodward**, F.R.S. The Lower Cretaceous formation of Bahia extends along the coast to a point 130 miles south of the area previously described. The fish remains are referable to new species of the genera Mawsonia, Lepidotus, and Scombroclupea. Mawsonia seems to have been scaleless, and differs from all known Jurassic and Cretaceous cœlacanth fishes in lacking denticles on the fins. The Lepidotus resembles the European Wealden *L. mantelli* in proportions, but is more strongly ornamented. The Scombroclupea is peculiar, in exhibiting only scales where the anal finlets usually occur.—The Bala and Llandovery rocks of Glyn Ceiriog (North Wales): Dr. T. **Groom** and P. **Lake.** The authors have mapped the district around Glyn Ceiriog on the 6-inch scale. The succession of strata is tabulated, and the characteristics of each bed given. No indication of the overlap or overstep of the Wenlock, Tarannon, and Llandovery beds mapped by the officers of the Geological Survey or described by previous observers was found, although there is probably an unconformity at the base of the Fron-Frys Slates. The beds of the district dip northwards at an almost uniformly low angle, but the structure is complicated by a series of faults, most of which have hitherto escaped notice, some being very elusive. The most important east-and-west fault is the Ddolhir fault, which dips at an angle of 20° nearly with the bedding, and may be either a thrust-plane or a lag-fault. Of the N.N.W. and S.S.E. or N. and S. faults, the most remarkable is the Caemor fault, on the east side of which the rocks have been raised nearly a mile, and shifted horizontally to the south for nearly three miles.

Faraday Society, May 26.—Sir J. Swan in the chair.—*Presidential address:* Some aspects of the work of Lord Kelvin: Sir Oliver **Lodge.** The president commenced by pointing out the difficulty of doing justice in the course of a short address to a man who, from an early age to an old age, had turned out such a prodigious amount of work, embracing practically all branches of physical science. Lord Kelvin had calculated the age of the earth, worked in the domain of electrostatics, optics, elasticity, telegraphy, beside many other practical subjects. These, however, had been dealt with by other appreciators. Sir Oliver himself would not touch upon the practical side of Lord Kelvin's work, but upon the more recondite and abstruse branches of his activity. He was not entirely able to agree with some of Lord Kelvin's assumptions, neither did he always consider that his practical work entirely bore out his conclusions. For instance, in the case of the kinetic theory of solidity, Kelvin seemed to consider that solids could be made from fluids and fluids from solids, and that matter might be ether in motion. But more recently he seemed to have rather changed his views, or at any rate modified them, and seemed satisfied with the postulate of action at a distance through space without the intervention of a connecting medium. Sir Oliver Lodge himself was unable to accept the explanation of action at a distance without the intermediary of some form of matter. Nothing in Lord Kelvin's work was finer than his publications in 1851, or showed the extraordinary keenness of mind aided by the tremendous natural powers which he possessed. His prescience was, at that date, even greater than that of Helmholtz. Posterity will probably consider that the greatest of all his work was that upon the conservation of energy and his enunciations upon the laws of thermodynamics. This part of the discussion was illustrated on the blackboard by mathematical formulæ. Reference was also made to the importance of his work upon absolute measurements, and Sir Oliver Lodge pointed out that some persons appeared to think that absolute measurements meant the metric system, but it did not matter in the least what units were employed so long as they were understandable.

Zoological Society, May 26.—Prof. E. A. Minchin, vice-president, in the chair.—Mammals collected by Mr. C. H. B. Grant near Tette, Zambesia, being the tenth and last of the series of papers on Mr. C. D. Rudd's exploration of South Africa: Oldfield **Thomas** and R. C. **Wroughton.** The importance of this collection was due to the fact that Tette was the place where Dr. Peters obtained most of the specimens on which his "Säugethiere von Mossambique" (1852) was based, and the specimens now collected were therefore topotypes of his species, and in consequence of great value in working out South African mammals in general; 104 specimens were referred to, belonging to thirty-two species. The exploration had lasted five years, and its results formed the largest and most complete collection that the National Museum had ever received from any one source. Besides duplicates, 1541 specimens had been registered in the museum, a large number of new species and subspecies had been discovered and described, and many more old and inexactly described species were now represented by good series of well-prepared skins and skulls. The collection had, in fact, revolutionised our knowledge of South African mammalogy, and it was impossible to exaggerate the benefit that such an exploration was to zoology in general and to the National Museum in particular.—The small collection of terrestrial Isopoda made by Dr. Cunnington on the third Tanganyika expedition: Rev. T. R. R. **Stebbing.** The collection consisted of four species. For two of these the author instituted the new genus Anchiphiloscia, distinguished by more penicils on the mandibles and a different cleavage of the second maxillæ from Philoscia as founded by Latreille in 1804. The paper insisted on the need of some enthusiast able and willing thoroughly to revise all the forms which had clustered under and about the generic name Philoscia.—The anatomy of Antechinomys and some other marsupials, with special reference to the intestinal tract and mesenteries of these and other mammals: F. E. **Beddard.** With the aid of a series of diagrams, the author described four grades or types into which he divided the modes of suspension of the mammalian intestinal tract.—The dermal armour of the extinct reptiles of the genus Pareiasaurus: Prof. H. G. **Seeley.** The existence of a dermal armour in Pareisaurus had been doubted by some authors, but Prof. Seeley was able to exhibit some actual specimens of scutes which had been obtained by Mr. J. Van Renen south of Fraserberg, Cape Colony.—Prof. **Seeley** also exhibited the skull of an extinct reptile of the genus Diademodon, on which he proposed to found a new species, and gave an account of the further evidence which it afforded of the structure and dentition of these South African reptiles.—Descriptions of many new species of Siphonaptera: Hon. N. Charles **Rothschild.**

DUBLIN.

Royal Dublin Society, May 19.—Prof. Young, F.R.S., in the chair.—Mendelian characters among Shorthorn cattle: Prof. J. **Wilson.** The author showed that in the matter of colour Shorthorn cattle display Mendelian phenomena, and that the reds and whites are the parent races, while the roans are intermediate hybrids. In support of this he quoted data collected for another purpose by Miss Barrington and Prof. Karl Pearson, which were published in *Biometrika* (vol. iv.). For the purpose of his paper the author pointed out that Barrington and Pearson's data were not complete, inasmuch as they left out of account several factors that cause the registration of Shorthorn cattle to be inaccurate. The author collected new data, in which the inaccuracies are eliminated as far as possible. He also gave a short account of the origin of Shorthorn cattle and of the history of the three races of cattle now found in the British Isles, viz. the black Celtic race, the white Roman race, and the red Saxon race.—Injurious insects and other animals observed in Ireland during the year 1907: Prof. G. H. **Carpenter.** The paper included records of several insects feeding on tobacco, including the caterpillars of *Mamestra oleracea* and *M. brassicae*, and a springtail—*Isotoma tenella*, Reuter—new to the Britannic fauna. The storehouse beetle, *Ptinus tectus*, Boield., lately introduced into Great Britain, has now appeared also in the suburbs of Dublin.

PARIS.

Academy of Sciences, June 1.—M. H. Becquerel in the chair.—The fossils of Patagonia. Economy in nature: Albert **Gaudry.** A comparison of the remains of mammals of the Patagonian region with those of this hemisphere shows no reason for supposing that there were two centres of creation; but during Tertiary times evolution has taken place in the two hemispheres differently, continuing in the one and being arrested in the other.—New observations on Etna: A. **Lacroix.** The eruption has been studied from the observatory, situated at an altitude of 2942 metres, and at the foot of the terminal cone, 1 kilometre from the crater. The clouds emitted are compared with those of Mont Pelée, and details are given of the field within which fresh openings have been produced, and of the materials projected by the explosions of the central crater.—Some points relating to the pathogeny of congenital deformities of the face: M. **Le Dentu.** A general review of the theories of malformation is given, the statistics relating to the influence of heredity being considered in some detail.—The stability of auto-excited alternators working in parallel: M. **Dumoulin.** A study of the effect of adjusting the brushes of the rectifier supplying the inducing current.—Two different states of the iron arc: H. **Buisson** and Ch. **Fabry.** The first state of the arc, which is stable only when the current is intense, can be made to pass over into the other by introducing a large resistance into the circuit, the electromotive force being high, 220 to 440 volts. The phenomena observed are compared with those shown by the arc between carbon poles.—The hydrates of the fatty acids determined from measurements of the viscosity of their solutions: D. E. **Tsakalotos.** These measurements lead to the conclusion that there is no combination between formic acid and water, whilst acetic, propionic, and butyric acids form molecular combinations containing one molecule of water to one molecule of the acid.—The action of ammonia upon phosphorus chloronitride: MM. **Besson** and **Rosset.** With dry liquid ammonia the product of the reaction is $PN(NH_2)_2$; gaseous ammonia acting on a solution of the chloronitride in carbon tetrachloride gives a different substance,

$$P_2N_2Cl_3(NH_2),$$

soluble in carbon tetrachloride.—The acid phosphoric esters of guaiacol: V. **Auger** and P. **Dupuis.**—The mechanism of cyclic formation in the geranic series; the synthesis and structure of dihydromyrcene: M. **Tiffeneau.**—Researches on protoplasmic hydrolysis: A. **Etard** and A. **Vila.** It is pointed out that the current methods of separating and determining the nitrogenous products of the hydrolysis of protoplasmic substances entail unavoidable losses.—The relations between the microgranites and the diabases of the Meuse valley: J. **de Lapparent.** It is concluded that the eruption of the microgranites of the valley of the Meuse is of a later date than that of the diabases. At the moment of the eruption of the microgranites the magma of the diabases had not consolidated.—A new genus, *Lecythodytes paradoxus*, a parasite of the Chrysomonadineæ: P. A. **Dangeard.**—The propagation of some species of mosses of the genus Barbula under certain experimental conditions: Jacques **Maheu.**—The pallial defensive glands in *Scaphander lignarius*: Rémy **Perrier** and Henri **Fischer.**—The most recently discovered drawings in the Portel (Ariège) grotto: A. **Breuil**, L. **Jammes**, and R. **Jeannel.** In a branch of the main cavern, unnoticed until recently, a fresh set of palæolithic drawings has been found. These include pictures of a small bison and a horse, reindeer, and wild goat. Evidence of the presence of small bears in this cave has also been found.—The entoptoscope, an instrument for examining the macula: Paul **Fortin.**—Radioscopy in forensic medicine: F. **Bordas.** In determining whether an infant has breathed or not, radiography cannot be substituted for the methods in current use. It is, however, of service in furnishing the expert with a photographic document, which may be used as supplementary evidence.—A new thermo-pulveriser worked by means of compressed air: M. **Guyenot.** The various forms of apparatus in current use for producing sprays of aqueous solutions for therapeutic purposes cannot be used for a higher temperature than 25° C. In the apparatus described and figured in the present paper, any temperature up to 50° C. can be maintained at will.—Researches on the food of the typhoid bacillus: H. **Dunschmann.** A comparison of the nutritive effects of bile salts on the typhoid and coli bacilli.—The utilisation of concentrated saline solutions for the differentiation of bacteria. The separation of *Bacillus typhosus* from *Bacterium coli*: A. **Guillemard.** A strong saline solution, such as one containing 20 per cent. of sodium sulphate, causes differences in the growth of cultures of the typhoid and coli bacilli, by means of which they can be readily differentiated. Other bacilli have been studied from the same point of view.—The presence of Hippurite grit at Vence, Alpes-Maritimes: V. **Paquier.**—The Cretaceous and Tertiary strata in the region of Constantine, Algeria: E. **Joleaud.**—The use of Daguin's *acoustèle* for the detection of subterranean sounds: F. **Diénert,** A. **Guillerd,** and M. **Marrec.** An account of the application of this instrument to the tracing of currents of underground water by means of the sound produced by the stream. The method is only successful in a few limited cases.—The influence of the wind on the filling up of the bed of the ocean: M. **Thoulet.**—Contribution to the study of the Landwasser river and the Davos valley: Gabriel **Eisenmenger.**

## DIARY OF SOCIETIES.

*THURSDAY*, JUNE 11.

MATHEMATICAL SOCIETY, at 5.30.—Electrical Resonance: Prof. H. M. Macdonald.—Relations between the Divisors of the First *n* Numbers (second paper): Dr. J. W. L. Glaisher.—The Formation of Fundamental Harmonics: Prof. A. E. H. Love.

*FRIDAY*, JUNE 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Considerations on the Form and Arrangement of New Tables of the Moon: Simon Newcomb.—On the Orbit of $\beta$ 416: J. Voûte.—An Example of Prof. Karl Pearson's Calculation of Correlation in the Case of Periodic Inequalities of Long Period Variables: H. H. Turner.—On the Parallax and Proper Motion of the Double Star Krueger 60: E. E. Barnard.—Observations of Daniel's Comet (*d* 1907): Radcliffe Observatory, Oxford.—The Lunar Bright Rays: H. G. Tomkins.—Observations of Helium $D_3$ Absorption in the Neighbourhood of Spots in 1907: Capt. R. A. C. Daunt.—The Radius of the Moon for Libration −4″·5: Walter Heath.—*Probable paper:* Report on Observations of the Total Solar Eclipse of 1908 January 3: F. K. McClean.

ARISTOTELIAN SOCIETY (at Cambridge).—Symposium: The Nature of Mental Activity: Profs. S. Alexander, James Ward, Carveth Read, and G. F. Stout.

PHYSICAL SOCIETY, at 8.—Experiments on a Directive System of Wireless Telegraphy: Messrs. Bellini and Tosi.—On the Lateral Vibration and Deflection of Clamped Directed Bars: Dr. Morrow.—On the Resistance of a Conductor of Uniform Thickness whose Breadth Suddenly Changes, and on the Shapes of the Stream-lines: Prof. Lees.—On the Self-inductance of Two Parallel Wires: Dr. Nicholson.—On Homogeneous Secondary Radiation: Dr. Barkla and Mr. Sadler.—Notes on the Motion of a Corpuscle and on Cloud Formation: Prof. Morton.

GEOLOGISTS' ASSOCIATION, at 8.—Origin of Mountain Tarns: Prof. E. J. Garwood.

*MONDAY*, JUNE 15.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Journey on the Upper Salwin: George Forrest.

*TUESDAY*, JUNE 16.

ROYAL STATISTICAL SOCIETY, at 5.

ZOOLOGICAL SOCIETY, at 8.30.—The Duke of Bedford's Zoological Exploration of Eastern Asia.—X. List of Mammals from the Provinces of Chi-li and Shan-si, N. China: Oldfield Thomas, F.R.S.—On a Case of Imperfect Development in *Echinus esculentus*: James Ritchie and D. C. McIntosh.—Observations on the Minute Structure of the Spicules of Calcareous Sponges: Prof. E. A. Minchin and D. J. Reid.—Two New Genera and a New Species of Indian Lycænidæ: Dr. T. A. Chapman.—A Contribution to the Knowledge of *Rhinoderma darwini*: F. E. Beddard, F.R.S.—Some Notes upon the Anatomy of *Chiromys madagascariensis*, with References to other Lemurs: F. E. Beddard, F.R.S.—*Leucocytozoön musculi*, sp. n., a Parasitic Protozoön from the Blood of White Mice: Miss Annie Porter.

MINERALOGICAL SOCIETY, at 8.—On a Nickel-iron Alloy Common to the Meteoric Iron of Youndegin and the Meteoric Stone of Zomba: L. Fletcher, F.R.S.—Kaolinization and other Changes in West of England Rocks: F. H. Butler.—On Schwartzembergite, and the Drawing of Light Figures: Dr. G. F. Herbert Smith.—The Chemical Composition of Seligmannite: Dr. G. T. Prior.

*WEDNESDAY*, JUNE 17.

GEOLOGICAL SOCIETY, at 8.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—An Elementary Explanation of Correlation, Illustrated by Rainfall and Depth of Water in a Well: R. H. Hooker.—The Hong Kong Typhoon, September 18, 1906: L. Gibbs.

ROYAL MICROSCOPICAL SOCIETY, at 8.—On Cycloloculina, a New Generic Type of the Foraminifera: E. Heron-Allen and A. Earland.—Illuminating Apparatus for the Microscope: J. W. Gordon.—*Exhibits:* A New Lens for High Power Microscopy: Mr. Gordon and H. Fletcher Moulton.—The Development of the Chick: A. Flatters.

*THURSDAY*, JUNE 18.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* (1) An Electrical Method of Counting the $\alpha$ Particles from Radio-active Matter; (2) The Charge and Nature of the $\alpha$ Particles: Prof. E. Rutherford, F.R.S., and Dr. Hans Geiger.—The Scattering of the $\alpha$ Rays by Matter: Dr. Hans Geiger.—Studies of the Processes Operative in Solutions. Part VI., Hydration, Hydrolation and Hydrolysis as Determinants of the Properties of Aqueous Solutions; VII., The Relative Efficiencies of Acids as deduced from their Conductivities and Hydrolytic Activities; VIII., The Influence of Salts on Hydrolysis and the Determination of Hydration Values; IX., The Determination of Optical Rotatory Power in Solutions; X., The Changes Effected by the Reciprocal Interference of Cane Sugar and other Substances (Salts and Non-electrolytes): Prof. H. E. Armstrong, F.R.S., and others.—The Electrolytic Properties of Dilute Solutions of Sulphuric Acid: W. C. D. Whetham, F.R.S., and H. H. Paine.—The Giant Nerve Cells and Fibres of *Halla parthenopeia*: Dr. J. H. Ashworth.

CHEMICAL SOCIETY, at 8.30.—The Thermal Decomposition of Hydrocarbons, Part I., Methane, Ethane, Ethylene and Acetylene: W. A. Bone and H. F. Coward.—The Rusting of Iron: W. A. Tilden.—Studies on Elementary Zirconium: E. Wedekind and S. J. Lewis.—(1) The Constituents of Canadian Hemp. Part I., Apocynin; (2) A New Synthesis of Apocynin: H. Finnemore.—The Constitution of the Diazonium Perbromides: F. D. Chattaway.—Cholestenone: C. Dorée and J. A. Gardner.—A New Form of Potash Bulb: A. E. Hill.—Solubility of Silver Chloride in Mercuric Nitrate Solutions: B. H. Buttle and J. T. Hewitt.

LINNEAN SOCIETY, at 8.

## CONTENTS.

THURSDAY, JUNE 18, 1908.

## THE FRESH-WATER FISHES OF CENTRAL AMERICA.

*Biologia Centrali-Americana. Pisces.* By C. Tate Regan. Pp. xxxiii + 203; with 26 plates and 2 maps. (1906–8.)

WE have to congratulate the editor of this magnificent work on the regularity with which the issue of the parts, now 200 in number, is proceeding, thus bringing its completion within measurable distance. Many a time, when, during its progress, collection after collection arrived, each bringing insects in tens of thousands, besides specimens of almost every other class of animals, the prospect of completing the work must have appeared almost hopeless, and this still more so when the editorial labours were thrown entirely upon Mr. Godman after the death of his coadjutor, Osbert Salvin. When the founders of the "Biologia" planned the work, now some forty years ago, they were moved to this grand enterprise by a clear perception of the important bearing which an intimate knowledge of the fauna of Central America, as a transition area between the Nearctic and Neotropical regions, must have upon the wider questions of the changing distribution of animals generally, and of their evolution since Tertiary times. But we believe that their original estimate, both of the number of species and of the extent of the work, was greatly exceeded in the course of those years. Nevertheless, their determination and energy have never failed them.

The volume with which we propose to deal on the present occasion is that containing an account of the fishes. Its appearance marks also the completion of the whole division of vertebrates. The preparation was entrusted to Mr. C. Tate Regan, who by his previous work on Neotropical fishes had shown himself eminently qualified for the task. The editor was most fortunate in his selection, for in the short space of two years he saw a work completed which was not only difficult in itself, but was rendered more laborious by the numerous contributions to Central American ichthyology which have appeared during the last two decades, and which, of course, had to be carefully consulted and studied.

The author has restricted himself almost entirely to fresh-water fishes and to such marine forms as are known to ascend rivers beyond the influence of the tide. In accordance with the plan generally followed in the "Biologia," detailed descriptions, with full references to previous publications, are given in the case of groups or species which to the author appeared to need revision, and for which the requisite materials were to be found in the British Museum. The remainder are merely mentioned by name, with the addition of such distinctive characters as may be compressed in a synopsis or key.

We find, then, that the number of species described is 330, including some truly marine forms which for comparison, or other reasons, had to be referred to. This is a surprisingly small number considering that about 700 reptiles and 200 batrachians are known from the same area—an area which has been peopled from two regions, the Nearctic and the Neotropical, and also by migrations from two oceans; offering every variation of physical condition most favourable to the development of fish-life; intersected by networks of river systems, without intercommunication; and with large expanses of water severally containing numerous representatives of the same genus. An area such as this must nourish a multitude of specific forms, of which only a fraction are as yet known to us. We can therefore fully concur with the author when he says that our knowledge of the fishes of Central America and Mexico must still be regarded as very incomplete. He directs attention to the fact that not a single fresh-water fish has as yet been described from Honduras or from Nicaragua north and east of the Great Lakes. He might have added that fishes, for obvious reasons, are not favourites with the generality of collectors. Extensive collections are only made by those who are especially interested in the subject; and we believe that since Salvin, assisted by Capt. Dow and Mr. Godman, formed his collection, no other of equal extent has been made, unless it be that of Mexican fishes, brought together by Dr. Meek. We must not omit to mention here that the acquisition by the British Museum of numerous types or co-types from various, especially American, sources is chiefly due to the efforts of Mr. Regan himself.

The systematic work has been carried out in every detail with painstaking care and accuracy. Generally we notice with pleasure that in nomenclature he has kept free from the crotchets of modern reformers, and has remained faithful to the classical spirit which one expects to find in a Cambridge graduate. With the rich materials at his disposal, and the additional information contained in the writings of his contemporaries, he has aimed at a precise definition of genera and species, by which their identification has been much more facilitated than if he had prepared those lengthy descriptions which too frequently prove a snare for the student.

We cannot enter more fully into the treatment of the subject in the systematic section of the work, involving in the case of almost every species questions of a purely technical nature. But there is one point which may be mentioned, if only as a suggestion to other authors engaging in similar work. Students would find it a great boon if direct references to good illustrations were always admitted in the "synonymy," instead of references merely to some recent publication, in which they learn for the first time that such illustrations exist. Furthermore, in the case of the "Biologia," it would have been particularly appropriate to give direct references to figures of species discovered by Salvin, and drawn from specimens collected by him. We allude, *inter alia*, to the genus Heros and its allies, for which Mr. Regan has adopted the Swainsonian name "Cichlasoma." [1]

[1] Should be superseded, according to modern nomenclature, by the prior Cichlaurus!



H

In his Introduction the author discusses some questions of more general interest. After having devoted a chapter to the classification of fishes, with special reference to the Central American families, explaining the grounds on which he differs from some of the generalisations proposed in recent years, he proceeds to summarise the conclusions at which he has arrived with regard to the geographical distribution of the fresh-water fishes. He begins with a description of the range of the ten Central American families and of many of their genera, tracing their origin and migrations. Thus he says of the Cichlidæ (*alias* Chromides):—

"The Mexican and Central American Cichlidæ are more specialised than the South American ones, and have certainly been derived from them; not one of the genera with three anal spines is found north of the Isthmus of Panama, and all the South American Cichlidæ have simple conical teeth."

He rejects the hypothesis of a northern origin of Cichlidæ and of their southward migration into South America, Africa, and Southern India, and adopts the view expressed by other zoologists that

"In early Eocene times Africa was connected by land with South America on the one side, and with India, *via* Madagascar, on the other."

On the other hand, he takes the Cyprinodontidæ to be an originally Holarctic group, which, moreover, was confined primarily to fresh water. His principal reasons for the latter assumption are:—(1) their absence from the Australian region, except for a species of Haplochilus in Celebes and Lombok[1]; and (2) the fact that all fossil Cyprinodonts known are from fresh-water or estuarine deposits. Singularly enough, while in the old world all the species retained their oviparous habit, a very large number of the American forms became viviparous; and it is in Central America that some of the most specialised genera were developed within comparatively limited districts. Anableps is considered to be endemic to South America, one Central American species being an immigrant from the South.

The Centrarchidæ are also a northern type which is making its way southwards into Central America. Of about thirty species, six extend southwards to the Rio Grande, and one a little further into Tamaulipas. We are glad to see that the author vindicates the North American integrity of this group from the attempt to associate with it the Indo-Pacific Kuhlia and its Australian fresh-water allies.

These brief extracts will suffice to direct attention to the many very interesting points on which the author's thorough acquaintance with the subject enables him to speak with authority. Several woodcuts accompany the text, illustrating the distribution of the Central American families over the globe; and on two plates the northern range of Neotropical and the southern range of Nearctic families and subfamilies are shown.

In the division of the Central American sub-region into provinces, the author does not carry us on firmer ground than had been reached by previous inquiries. However, he expresses it as his opinion that

"for fresh-water fishes the volcanic chain of mountains which stretches across Mexico from Colima nearly to Vera Cruz may be taken as the boundary between the Arctic and Tropical regions. This range has proved an insuperable obstacle to the northward migration of the Neotropical fishes."

Having thus established a northern and southern division, he distinguishes in the former three provinces, viz.:—

(1) Northern Mexico, west of the Sierra Madre.

(2) Rio Grande province.

(3) The Lerma system.

And in the latter:—

(1) The Rio Balsas system.

(2) Rio San Juan, with lakes Managua and Nicaragua.

(3) Guatemalan province.

(4) Isthmian province (Costa Rica and Panama).

The author cautiously adds that any division into provinces must be regarded at present as merely provisional, owing to our incomplete knowledge of the fish fauna of this area. We cannot help thinking that he would have much facilitated the labours of future inquirers had he followed the plan of other contributors and given a systematic index of species with a table showing their range so far as at present known.

Finally, in the last chapter of the introduction the author explains his views as regards the partial identity of the fish faunas of the two sides of the isthmus. He adopts the opinion of American ichthyologists that there are very few of the truly marine forms the representatives of which on the two sides cannot be shown to differ in some point; but on the present occasion he takes into consideration such only of the shore fishes as are known to enter fresh water. He has prepared a list of eighteen pairs of such fishes, each pair consisting of an Atlantic and a Pacific representative. The members of each pair differ from each other in various degrees; some of them differ in three or more "tangible," "substantive" characters (and no systematic ichthyologist would deny them specific rank), while others can scarcely be regarded "as more than subspecifically distinct." Thus, whatever method is followed by ichthyologists for taxonomic distinction, with the object of accentuating either the amount of differentiation that has taken place since the individuals were separated and isolated, or their previous and still more or less apparent identity, the similarity between species of both sides must be admitted by all to be so great as only to be explicable by a former communication between the two oceans.

The work is illustrated by twenty-six lithographic plates executed by Mr. J. Green in his usual excellent style, and we have to express our hearty thanks to Mr. Tate Regan for having contributed so careful and important a work to Godman and Salvin's great undertaking.

[1] Prof. Max Weber could hardly allow even this exception, having incontestably proved that the scanty fresh-water fauna of Celebes is merely an immigration from India.

## ROULETTE AT MONTE CARLO.

*La Loi des petits Nombres.* By M. Charles Henry. Pp. xiv+71. (Paris: Laboratoire d'Énergetique d'Ernest Solway, 1908.) Price 4 francs.

THE question discussed by the author may be given in his own words:—

"Est-il possible de prévoir une loi de séquence plus ou moins fragmentaire dans les phénomènes fortuits comme les arrivés de la rouge et de la noire à la roulette?"

He considers that the theory of probabilities is only verified in practice when the number of throws of the ball is indefinitely great, and that new principles are required when the period of play is short. He takes what he terms a psycho-physical point of view, and bases his researches on the ultimate vibrations of particles and the musical interval, the fifth—the ratio 3 : 2. He adopts the latter as governing the sequences at roulette without giving any scientific reason whatever.

It is difficult to take the author seriously, but as he pretends in chapter iv. of the work to give rules of play which will enable a player to win at Monte Carlo, it is necessary to inform the reader that the system of M. Henry is not based upon scientific truth, and can have no effect upon his winning or losing. It still remains true that the construction of the Monte Carlo roulette table gives an advantage to the bank, which, roughly, may be stated to be 1·35 per cent. on the even chances and 2·7 per cent. on the longer chances. The percentage refers to all the money placed upon the table that was originally in possession of one of the players. Should a player stake five francs on one of the even chances, the piece becomes immediately depreciated in value so as to be only worth four francs ninety-three centimes. Placed anywhere else on the table it is worth but four francs eighty-six centimes. If the stake be left upon the table for another coup, with or without previous winnings, a like depreciation takes place, and it is the sum of all these depreciations which in the long run constitutes the profit of the bank.

Statistics show that each table earns about 400*l.* per diem on the average. This shows that the amount staked at each table is about 20,000*l.* per diem. The nine tables in use during the winter months thus earn about 3600*l.* per diem, and the amount staked probably reaches the large figure of 180,000*l.* per diem. It may be regarded as certain that a large majority of the players leave off losers. Of these, certain individuals lose a small sum which they consider is sufficient to leave in the rooms; others a sum which they had previously determined not to exceed; others sums which are in excess of what they wished to lose. On the other hand, a minority of the players will be winners, but this minority becomes smaller as the average time during which the players remain at the table becomes larger.

Many of the players have probably been winners at some time or other during the play. They determined to become larger winners, with the final result that they were losers. Few players know when to stop the game and to hold their hands when a reasonable sum, reasonable in proportion to the playing capital, has been won. The consequence of a player with a moderate capital thus settling down to play the bank for immoderate winnings is in the long run certain ruin, whether the bank has between one and three per cent. in its favour or not.

The large capital of the bank gives it an advantage over the player, whose capital is relatively small, which is quite separate from the advantage derived from the design of the table.

The influence of capital can be well seen in an ordinary even game of rouge et noire. We may suppose Peter and Paul to be the players, and the stake to be 1*l.* at each coup. It is quite certain, whatever be the capital of each, that after a sufficient number of coups one or other will lose all his capital. Which of the two has the greatest chance of being ruined depends upon the ratio between the capitals. It can be shown that Peter's chance of ruining Paul bears the same ratio to Paul's chance of ruining Peter that Peter's capital bears to Paul's. If Peter's capital be 50*l.* and Paul's 40*l.*, it is 5 to 4 that Peter ultimately ruins Paul. The circumstance that the game, if continued long enough, will inevitably lead to the ruin of one of the players may seem surprising to one who has not given the subject special attention. There is a popular fallacy that in the long run Peter and Paul will win very nearly the same number of coups. The fact is that in the result of a large number of coups the ratio of the numbers of coups won by the players approaches unity, but that the difference between these numbers has a tendency to increase beyond any limit. Great as is the advantage of a large capital, it cannot be inferred that the bankers at roulette could afford to play with tables not constructed to their advantage, because then there would be nothing to hinder a combination of capitalists from placing themselves on more than even terms with the bank. So great is the advantage of the bankers due to their large capital that, failing a combination against them, they could afford to play with a table constructed against themselves and in favour of the players.

If the respective capitals of the bank and of a player be known, it is not difficult to design a table which will place the two sides on an exact equality as regards play on the even chances for an unlimited time. When the bank has practically an unlimited number of stakes the solution is very simple, and may be stated as follows:—If the player possess a certain number of stakes, he should be able, from the construction of the roulette, to win on the average a majority out of four times that number of coups. A player with fifty stakes should be able to win 101 coups out of 200. In this case the roulette should have one zero and 100 numbers, and the zero should be in favour of the player. On the existing roulette tables a player with nineteen stakes and the zero in his favour would be on even terms with the bank. There would not be more than an even chance of his final ruin.

The above facts should become known to intending players, so that they may not be misled into thinking that they will make their fortunes by following the advice given in M. Henry's book. That book adds nothing to our knowledge of the probabilities connected with roulette at Monte Carlo.

## THE THEORY OF LIGHT.

*The Theory of Light: A Treatise on Physical Optics.* By Richard C. Maclaurin. In three parts. Part i. Pp. viii+326. (Cambridge: University Press, 1908.) Price 9s. net.

THIS is the first instalment of a work on optics arranged on a somewhat novel plan. The volume treats mainly of the propagation of light in homogeneous media, isotropic or crystalline, and of the laws of reflection and refraction at plane boundaries. It is to be followed by a second dealing with the subjects of diffraction, dispersion, aberration, &c.; whilst a concluding volume is to be devoted to the history of optical theory. The method followed is deductive; a medium of the McCullagh type is postulated, and the laws of wave-motion are obtained by an application of the principle of Action. This is practically, of course, the electric theory of light in the form adopted by Larmor. The subsequent developments are naturally almost entirely mathematical, experimental methods being rarely referred to. For this reason the work cannot claim to be, indeed does not profess to be, a complete handbook of the subject; but this is hardly to be regretted, since the English student already has within his reach two masterly expositions from the physical standpoint in Lord Rayleigh's *Encyc. Brit.* article, and in Prof. Schuster's "Optics." A more serious matter is that some recent speculations of importance are ignored. For instance, we read on p. 29:—

"The answer forced upon us by the experimental evidence is that we must regard the [components of white] light as polarised elliptically . . . for an interval of time which is long compared with the period of vibration, but very short compared with the time required to make any impression on the retina or on a photographic plate."

This brings us back to the standpoint of Airy's "Tracts." It is to be hoped that the author will return to this question in his second volume, and that the bearing on it of Rayleigh's and Schuster's work on interference will receive due consideration.

The real value of the book consists in the systematic mathematical discussion of various classes of phenomena from a common point of view. In particular, many readers will be glad to have in an easily accessible form the author's own investigations of the effect of a thin transition layer in the phenomena of ordinary and crystalline reflection and refraction, and metallic reflection. Regard being had to the point of view, the style is clear and attractive, and the reader will appreciate the numerous excellent graphical representations of the somewhat complicated theoretical results.

In a lively introductory chapter the author discusses the methods and aims of science, the object being apparently to anticipate criticisms which might be directed against the special theoretical basis which he has adopted for his exposition. This discussion is pleasant reading enough, but it is to be hoped that future writers on mathematical physics will not always think it necessary to begin in this way. From the student's point of view the procedure has this disadvantage, that he may find the introduction much harder than the book, and perhaps even not intelligible until he has read the book. In the present instance the opening sentence tells us that "the first question in the catechism of every physicist" should be "what is the chief end of science?" The author's own reply to this question is interesting, and has the present writer's sympathy, but one cannot help wondering what degree of uniformity would be found among the answers which would have been given by, say, Archimedes, Galileo, Newton, Pascal, Laplace, Young, Maxwell, Kelvin. Fortunately history shows that the progress of science is not really conditional on the correct resolution of so formidable a question, any more than art has ever stood still for want of a definitive reply to the other secular question, what constitutes the Beautiful?

The remaining volumes will be looked forward to with interest, and the historical section in particular should prove of great value. H. L.

## GEOLOGICAL EPITOMES.

*Die Alpen.* By Dr. Fritz Machaček. Pp. iv+146. (Leipzig: Quelle and Mayer, 1908.) Price 1.25 marks.

*Eiszeit und Urgeschichte des Menschen.* By Prof. Hans Pohlig. Pp. viii+142. (Leipzig: Quelle and Mayer, 1907.) Price 1.25 marks.

THESE two books, bound in cloth and convenient for the pocket, are members of Dr. Paul Herre's series entitled "Wissenschaft und Bildung." They are printed in the older German type, presumably to give them a popular and untechnical aspect; and their cheapness prevents their half-tone illustrations from being more than suggestive. But the text is by no means of the "nature-study" order, or merely intended to lead a young reader on to better things; it is rather a summary of the results of a wide range of specialised research.

Dr. Machaček in his volume compares the views of various authors on the structure of the eastern and the western Alps, and discusses the origin of the present surface-relief. He accepts the theory of glacial erosion for the "Zungenbecken" of the North Italian lakes as a logical outcome of observations on the deepening of the main glaciated valleys further up among the Alps; and he attributes the rich variety of pictorial features (p. 56) in the central chain to the denuding activities of the Ice-age. Surely no one can nowadays deny the efficacy of "frost-nibbling" in producing crags and *cirques* and wild *arêtes*, when combined with the presence of glaciers, which carry off the débris from the scene of severest action. Nor can the modification in form of the original valleys excavated by streams be ascribed to anything but the eroding power of the glaciers themselves, well armed with materials gathered all along their course.

Dr. Machaček proceeds to describe the Alpine climate, the flora and fauna, and the influence of the topography upon human occupations. We cannot help thinking that a similar book for English readers would have been written with the view of attracting the ordinary tourist. Dr. Machaček, on the other hand, in pursuance of the plan of the series, aims at giving systematic information to those who may never see the Alps, but who regard them as features about which something should be known. There is a Teutonic touch in this; but to pursue this aspect of a cheap handbook, which is presumably meant to sell by thousands, would be to raise all manner of questions about the level of our own public education.

Prof. Pohlig has also a good deal to say about glaciation. His sketch of the geological history of the earth (pp. 2–4) leads up to the glacial epoch, and presumes with some audacity that the first continents appeared in Carboniferous times, and that the first marked differentiation of climatic zones took place in the later part of the Cainozoic era. An Ice-age affecting the whole globe seems a very chilly preparation for the coming of man, though Dr. Pohlig regards these occurrences as in some way connected. We are tempted to ask what organic change was heralded by the Permo-Carboniferous Ice-age, which does not seem to be referred to? The book is based on lectures by the author, and retains the vigour of style of one who is not afraid of controversy. There are even references, thinly veiled, to persons who have come off badly in the fray (pp. 74 and 96). The descriptions of the types of early man, and of the mammals associated with him, are of special interest. A larger number of specific names is employed for the latter than zoologists usually accept. From the description of the splendid Scandinavian boulders scattered over Holland and North Germany (which surely travelled more rapidly than the author suggests), down to the subdivisions of the giant deer, the book has an individuality about it which marks it out agreeably among compendiums of useful knowledge.

G. A. J. C.

## NEW ZEALAND PLANTS.

*Plants of New Zealand.* By R. M. Laing and E. W. Blackwell. Second and revised edition. Pp. xii+454; illustrated. (Christchurch, Wellington, and Dunedin, New Zealand; Melbourne and London: Whitcombe and Tombs, Ltd., 1907.) Price 15s. net.

WE are glad to welcome the second edition of this interesting book, which is essentially a popular account of the flowering plants of New Zealand, exclusive of the grasses. It appears that no less than 1400 species of flowering plants are now known to be indigenous within the limits of the dominion, and doubtless others remain to be discovered in the more remote mountain ranges and outlying islands. No less than three-quarters of the whole appear to be endemic, comprising many species of singular beauty and scientific interest. Thanks to the energy of local botanists, great strides have been made during recent years in our knowledge of this wonderful flora, and the earlier descriptive work of Hooker, based largely upon dry material, has been to a great extent supplemented by investigations of the living plants in their native environment.

The chief merit of the volume before us lies in the numerous beautiful photographic illustrations of the more conspicuous species, upon the selection and execution of which the authors are to be sincerely congratulated.

A general introduction gives a short account of the principal features of the vegetation of the open country, the fern land, the bush, the scrub, and the alpine regions. Throughout the work, indeed, a large amount of attention is devoted to œcological problems, very extensive use being made of the recent work of Dr. Cockayne in this direction. This feature, together with the frequent references to Maori legend and tradition, give to the work an unusual interest. The general introduction also includes a discussion on the affinities of the New Zealand flora, which is perhaps a little out of place in a work of this character, though interesting in itself. The relationship to Australia is emphasised by the statement that 80 per cent. of the genera are common to the two countries, and explained by the common origin of a large part of the two floras from the north by way of a northern extension of the land in Eocene times, which also accounts for the subtropical facies of the New Zealand flora as a whole. The absence of many of the most important Australian genera, such as Eucalyptus, Acacia, Casuarina, Hakea, is perhaps to be explained in accordance with Wallace's well-known theory of the separation of Australia into two islands in Cretaceous times, to the western of which the most characteristic Australian genera were confined.

Other important elements in the New Zealand flora are the South American and sub-Antarctic. The former, illustrated by the genera Fuchsia and Calceolaria, may perhaps be explained in accordance with the late Captain Hutton's theory of a Pacific continent connecting New Zealand and New Guinea with Chili in Cretaceous or early Eocene times, while the latter may be similarly accounted for by the existence of a number of islands in the Antarctic ocean in Pliocene times which have since disappeared.

A very short "Botanical Introduction" appears to us to require elaboration and illustration in order to make it really intelligible to the uninitiated, to whom it is apparently addressed. A considerable advance upon previous works on the New Zealand flora is made in the abandonment of the familiar system of Hooker and Bentham in favour of Engler's arrangement of families.

The book is well got up, but somewhat uncomfortably heavy, especially as a travelling companion, for which purpose it ought to be largely in demand. In future editions a little more care might advantageously be given to the page headings, several of which are at present very misleading.

A. D.

## OUR BOOK SHELF.

*Soils: their Nature and Management.* By Primrose McConnell. Pp. xii+104. (London: Cassell and Co., Ltd., 1908.) Price 1s. net.

In this little book the working farmer or gardener will find set out clearly and from his own point of view just that basis of the scientific knowledge of the soil that he ought to possess for the intelligent management of his land. The author, Mr. Primrose McConnell, is well known as a practical farmer, who has been trained in science and has shown a special interest in the application of scientific principles to the implements used for cultivating the land.

Mr. McConnell begins with an account of the origin of soils, their composition, classification, and distribution on the different formations of Great Britain, in which he gives some indication of where good and bad soils occur, and of their characteristic trees and weeds. The more valuable part of the book is, however, that which deals with soil physics and the effect of cultivation and management upon the all-important factor of the texture of the soil. The author is, as might be expected from a man accustomed to tillage operations, free from the temptation to regard the soil purely from the chemical point of view as a medium for the supply of the plant with certain salts; again and again he lays stress on the importance of tilth and the way it can be affected by the operations, both manurial and mechanical, of the farmer. In this direction it is very desirable that more experimental work should be done; the basis of the statements usually made as to the effect of various acts of husbandry upon the water content and temperature of the soil is astonishingly slight. For example, we should doubt a statement on p. 97 that rolled soil $1\frac{1}{2}$ inches below the surface may be 10° F. warmer than the same soil not rolled, as also the explanation which follows—but the experimental evidence we could bring against it is not so strong as the importance of the question would warrant.

Here and there throughout the book there are small mistakes and misreadings in dealing with scientific matters, but they are of small account, and do not touch the general course of the argument, so that we can cordially recommend the book to the class of readers for whom it was designed.

*The Life and Work of George William Stow, South African Geologist and Ethnologist.* By R. B. Young. Pp. vii+123. (London: Longmans, Green and Co., 1908.) Price 3s. 6d.

South African geology has yielded many results of world-wide interest, including the extinct fauna of the Karroo and the Palæozoic glaciation of South Africa. The debt due to George William Stow, the pioneer in the discovery of both subjects, will now be paid more easily owing to the admirable sketch of his career by Prof. R. B. Young. Geologists would, however, have been still more grateful for this biography if it had included a table of contents, an index, and a bibliography.

Stow was born at Nuneaton in 1822, and educated at a school on the Isle of Dogs. Though anxious to be an engineer, he was trained for medicine; but he did not qualify for practice, emigrated to South Africa in 1843, and lived there until his death in 1882. Considering the time and place in which his life was spent, it was apparently not rich in striking incidents or adventures. It was, however, during a trek to dodge the rebellious Kafirs in 1850 that he found in the Rhenosterbergen the first of the extinct reptiles of the Karroo. He fortunately reported his discovery to Prof. Rupert Jones, to whose help and encouragement Stow's services to geology are largely due. Stow's life was unsettled; he was thrice married, and in the search for a livelihood he was at different times teacher in the schools of the Colonial Church, book-keeper, trader at Queenstown, wine merchant at Kimberley, diamond merchant, geologist to the Orange Free State, and manager of the South African Free State Coal and Mineral Mining Association. His main scientific achievements were his discovery of the fossil reptiles of the Karroo, his recognition and proof of the glacial origin of the Dwyka conglomerate, his collection of Bushman drawings, his valuable memoir on the geology of Griqualand West, published by the Geological Society, and his two reports on the geology of parts of the Orange Free State, in which he described the geology of the area on the southern border of the Rand basin and part of the Vereeniging coalfield. Unfortunately, Stow's detailed account of the geology of Griqualand was never published, and the manuscript is now in the library of the Geological Society of South Africa.

Stow claimed the discovery of a second Cainozoic glaciation of South Africa, and in his glacial enthusiasm he described the diamond pipes of Kimberley as due to the action of ice. His view of a late Cainozoic glacial action in South Africa was at one time accepted in Europe, but is now discredited. His discovery, however, of the Upper Palæozoic glaciation has been confirmed, and will always give Stow's name an honoured place in the list of South African geologists.

J. W. G.

*Lessons in Hygienic Physiology.* By W. M. Coleman. Pp. ix+270. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1907.) Price 3s.

Of the many school physiologies, this is one of the best written, best arranged, and best proportioned. Since Huxley set the fashion more than a generation ago, the range of school physiology has remained pretty much the same; but there have been improvements in method. The method of this book is specifically adapted to the needs of teacher and pupil. All through, there are suggestions for making the teaching concrete, for "founding the study on facts and not mere words" (preface to the teacher). The illustrations are very varied, and set forth with many small original touches. The "review" and "thought questions" are obviously the careful work of an experienced teacher. Principles are never lost sight of, and the exposition never becomes mechanical or irrelevant, as so often happens when written examinations are the objective. But the book is admirably suited even for examinations. Taught as it may and should be taught, this little book should yield excellent results. Food and stimulants are specially discussed. The volume is one of a graded series.

*L'Aérobisation des Microbes Anaérobies.* By Georges Rosenthal. Pp. 107. (Paris: Félix Alcan, 1908.)

*Anleitung zur Kultur der Mikroorganismen.* By Dr. Ernst Küster. Pp. v+201. (Leipzig: B. G. Teubner, 1907.) Price 7 marks.

In his interesting essay, Mr. Rosenthal first describes the methods by which anaërobic microbes may be isolated and cultivated, then methods for measuring the degree of anaërobiosis, either by a pressure gauge fitted to an exhausted chamber or by the degree of growth occurring from above downwards in a tube containing a deep layer of culture medium, and, finally, the technique whereby different anaërobic organisms may ultimately be transformed into aërobic ones. This, according to the author, may be accomplished by simultaneously gradually admitting air and subculturing, so that a gradual acclimatisation to an aërobic condition is brought about; other methods are also described. The author then relates his experiences with such anaërobic organisms as the *Bacillus perfringens*, the bacillus of malignant œdema, and the bacillus of tetanus, and concludes with a critical examination of his results in order to detect fallacies.

Dr. Küster's little book will be very useful in the laboratory, as it gives a fairly complete summary, with bibliography, of the methods of isolation and cultivation of micro-organisms, including protozoa, myxomycetes, algæ, fungi, and bacteria, together with the formulæ and mode of preparation of the nutrient media. A book covering so wide a field will naturally be unequal, and the best sections are probably those dealing with the algæ, fungi, and special groups of bacteria.

R. T. HEWLETT.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### Distant Electric Vision.

REFERRING to Mr. Shelford Bidwell's illuminating communication on this subject published in NATURE of June 4, may I point out that though, as stated by Mr. Bidwell, it is wildly impracticable to effect even 160,000 synchronised operations per second by ordinary mechanical means, this part of the problem of obtaining distant electric vision can probably be solved by the employment of two beams of kathode rays (one at the transmitting and one at the receiving station) synchronously deflected by the varying fields of two electromagnets placed at right angles to one another and energised by two alternating electric currents of widely different frequencies, so that the moving extremities of the two beams are caused to sweep synchronously over the whole of the required surfaces within the one-tenth of a second necessary to take advantage of visual persistence.

Indeed, so far as the receiving apparatus is concerned, the moving kathode beam has only to be arranged to impinge on a sufficiently sensitive fluorescent screen, and given suitable variations in its intensity, to obtain the desired result.

The real difficulties lie in devising an efficient transmitter which, under the influence of light and shade, shall sufficiently vary the transmitted electric current so as to produce the necessary alterations in the intensity of the kathode beam of the receiver, and further in making this transmitter sufficiently rapid in its action to respond to the 160,000 variations per second that are necessary as a minimum.

Possibly no photoelectric phenomenon at present known will provide what is required in this respect, but should something suitable be discovered, distant electric vision will, I think, come within the region of possibility.

A. A. CAMPBELL SWINTON.

66 Victoria Street, London, S.W., June 12.

### Prominences and Coronal Structure.

PRESSURE of work in other directions prevented me from writing these lines before to-day. They have reference to an article contained in NATURE for April 2, in which Dr. Lockyer describes what he considers a triple concentric arc formation in the upper chromosphere similar to coronal structures observed during the eclipses of 1898, 1901, and 1905. Through the kindness of Prof. Hale, the British Astronomical Association is in possession of a photographic slide showing a composite calcium spectroheliogram taken of the sun's disc and chromosphere on July 17, 1907, *i.e.* the same date as the South Kensington one. Prof. Hale took the picture at 6.46 a.m. P.S.T., while Dr. Lockyer took his at South Kensington at 3.14 p.m. G.M.T. There is thus a difference of something like half an hour between the two exposures, that at Mount Wilson being the earlier one. Comparing the two spectroheliograms, it becomes evident that what Dr. Lockyer considers concentric coronal arcs, due to eruptive action either immediately in front or in the rear of the formation, constitute in reality the débris of an eruptive prominence. I happened to be observing the sun at the time, starting about 1.30 p.m. L.T., having also had the sun under observation early in the morning, and an extract of my notes reads thus:—

"July 17, 1907, 7 a.m.—In S.L.E. there is something hatching, the limb looking very uneven and the chromospheric lines contorted, with strong $D_3$ absorption effects being on view there from time to time.

"Ditto, 1.30 to 2.20 p.m.—Fine eruptive prominence in L.S.E., where something was preparing this morning. Great displacement of H$\alpha$ to red side, and the prominence seems to rush *en bloc* away from the observer and in an almost horizontal direction towards the south, rising radially but little, and dissolving from a stout, dense, and bright stem into a number of bright, more or less parallel layers or striæ."

Great activity continued in the S.E. quadrant for the next three days. The Mount Wilson picture shows what I observed in the spectroscope, viz. a strong dense stem breaking forth in lower L.S.E., curving immediately over to the south (as can be gathered from the great displacement observed, the real direction must have been *south-east*), the stem dissolving into a complicated structure of branches a good distance away to the south of the point of origin.

I had to leave the instrument at 2.20 p.m., when a few minutes later Prof. Hale in far-away California exposed his plate, to be followed soon after by Dr. Lockyer in South Kensington. It is quite feasible to think that when the exposure was made at South Kensington, the fragments, already in parallel arrangement when I left the instrument, partook also of some kind of concentric curvature, which is, indeed, indicated on Prof. Hale's spectroheliogram. As Dr. Lockyer mentions the absence of an *underlying* prominence to the concentric arcs he discerns in his picture, I deemed it in order to mention the above facts. I have not the slightest intention by so doing to doubt the great likelihood that concentric coronal arcs, such as those observed, for instance, by Mr. Wesley, are due to eruptive action from underneath, but in the case at present under consideration this seems not to have been the case in this more limited sense. I feel sure that Dr. Lockyer will come to the same conclusion when he compares the two spectroheliograms in the light of my observational notes given above.

ALBERT ALFRED BUSS.

2 Lansdowne Terrace, Grosvenor Square, Ashton-on-Mersey, near Manchester, May 28.

### The Action of Radium Salts on Glass.

THE letter of Mr. Phillip in NATURE of April 9 led me to examine some tubes containing radium salt which have been in my possession for some years. Some had become very purple owing to the action of the radium, whilst others were not coloured at all. The amount of coloration did not seem to depend upon the activity of the preparation; in fact, the deepest coloration—with one exception—was that due to a salt supposed to contain only one-thousandth of its weight of radium salt.

Certain kinds of glass when exposed to the bright sunshine of South Africa take a coloration similar to that produced by radium salt; I therefore thought that it might be interesting to observe the effect of sunlight upon a specimen of glass coloured by radium. With this object I exposed one of the coloured tubes to the action of the sunlight, and after twelve days' exposure the colour has been almost removed.

I have one tube which contained radium salt of about one million units activity; where the salt had rested against the tube almost black spots have developed. I shall expose this tube to the continued action of sunlight.

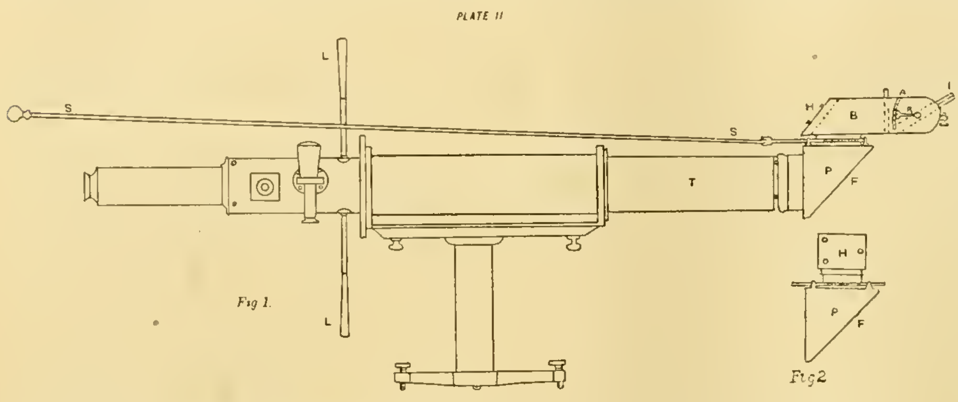
W. A. DOUGLAS RUDGE.

University College, Bloemfontein, O.R.C., May 14.

## *A FIELD METHOD OF DETERMINING LONGITUDES BY OBSERVATIONS OF THE MOON.*

A SHORT note appeared in these columns on April 23 (p. 590) with reference to a valuable paper by Mr. E. B. H. Wade, published by the Survey Department of Egypt. The paper, however, is one showing so much originality, and the instrument and method appears to be of such value, that a more extended notice is called for, the more so as the paper in question is by no means generally accessible.

Mr. Wade considers the case of field survey operations where at least one point, and preferably more, should be determined independently by a direct astronomical method. Latitudes are easy enough, and longitudes would be if telegraphic connection with an observatory were available. Until wireless time-signals are distributed over the world which might be picked up with portable receiving apparatus, the observer has to rely upon his chronometers, which become cumulatively misleading, or upon lunar observations. These latter, Mr. Wade points out, may be divided into two classes—those which depend directly upon the rotation of the earth, of which moon culmination observations serve as an example, and those which do not, for instance, lunar distances and occultations, and these have the advantage of being about thirty times less sensitive to errors of time.




The telescope T with its reflector F is mounted as an altazimuth, the motion in altitude being given by the handles L. B, the box-sextant, containing the horizon mirror H and index mirror I, is actuated by worm gear by means of the long handles, and so is made to turn about the reflected optic axis of the telescope, *i.e.* about a line at right angles to the axis of the actual telescope.

Mr. Wade has set himself to devise a method of making lunar distance observations with an accuracy outside the possible range of the sextant with apparatus that is easily portable. He refers to Talcott's method of determining latitude by observations of the equidistance of the zenith from two stars as compared with the actual measurement of its distance from a particular star. "In quite the same way" he suppresses "the graduated circle of the ordinary sextant and finds the moon's apparent position from the condition that it is equidistant from two or more stars, one of which, of course, must precede and the other follow the moon." By suppressing the graduated circle he removes the principal obstacle to the evolution of the sextant.

In order to arrive at this result, he starts with a good telescope of $2\frac{1}{2}$ inches aperture and magnifying 40 diameters, carrying a reflector set at 45° in front of the object-glass. The telescope is always horizontal, and can turn upon its longitudinal axis as well as upon its stand in azimuth. It therefore commands all points of the sky, and the observer can sit in comfort, a point essential for accuracy. The view of half the object-glass is intercepted by a second mirror set at 45°, which receives light from a third, which may be parallel with it or may be inclined at an angle of 10° or so, roughly indicated by a pointer. The real point is that at whatever angle it is set, it may be clamped infallibly until the observations are complete. The box containing these two last-mentioned mirrors is capable of slow rotation by means of a worm from the eye end of the telescope, so that if, for instance, these two mirrors were set at an angle of 5° and the worm were turned, the observer would see successively all points in a circle of 10° radius round the point to which the unintercepted part of the instrument was directed. Supposing now the moon to be observed directly, and a following star, which is just too far away to be brought into contact with the limb, to be seen by double reflection, then a slight sweeping motion may be given so as to ascertain the exact time of tangential contact. Similarly a preceding star which is just too near for a tangential contact may be observed until the moment at which this is seen also. Actually it is the star, not the moon, which is looked at directly, as by that means the moon's light after two reflections from unsilvered glass is sufficiently subdued to allow sixth-magnitude stars to be observed in contact. The designer has ingeniously introduced the equivalent of the spider lines of a transit instrument by providing a slightly prismatic plate which may be set in any one of three positions in one of the optical paths, thus making small but invariable differences in the apparent angle, so that three observations are possible for each star.

It will be seen, then, that the accuracy obtainable is only limited by the optical definition of the telescope.

Space is not available for following the author of the paper through his discussion of the observations or for referring to his excellent graphic methods for shortening the calculations where they are available. It is sufficient to say that with his apparatus he has found that the probable error of a single observation is of the order of 1·5 seconds of longitude.

C. V. BOYS.

## *THE CAVENDISH LABORATORY.*

ON October 10, 1870, the seventh Duke of Devonshire wrote to the then Vice-Chancellor of the University of Cambridge, offering to provide funds for a building and for apparatus for the teaching of experimental physics. The building was opened on June 16, 1874, when the Chancellor received the thanks of the University, and at the same time expressed his "wish to provide all instruments for the Cavendish Laboratory which Prof. Maxwell may consider to be immediately required either in his lectures or otherwise."

Twenty years later the laboratory was increased towards the south by a new building, running along Free School Lane, which contained, amongst other rooms, a spacious elementary laboratory. For this the University supplied the funds. The "Cavendish" is now, for the second time, being added to by a building which stretches along Free School Lane to the north, the new building being about 80 feet in length, and varying in width from 40 to 50 feet. The front to Free School Lane is of Weldon stone, with Ancaster dressings to the windows and where mouldings occur.

The new wing consists of three floors. The ground floor is occupied by a large class-room, two students' rooms, and two dark rooms. The lecture room, 40 feet by 30 feet, on the first floor, adjoins the preparation room containing a dark room, and there are also two other rooms, one for a library, the other for a common room for the demonstrators. On the second floor are nine students' rooms, a room for chemistry, and another dark room. Two floors of the new extension are thus devoted to research. There is ready access from all these rooms to the main laboratory.

The cost of the building will be between 7000*l*. and 8000*l*., and the University has only been enabled to undertake this work by the munificence of the Chancellor, Lord Rayleigh, who presented the whole of the Nobel Prize to Cambridge. Of this prize 5000*l*. is given towards the expense of the new laboratory, and Prof. Thomson has undertaken to provide 2000*l*., which has accumulated from laboratory fees. On Tuesday, June 16, thirty-eight years ago to the day, the first building of the Cavendish Laboratory was opened by the then Chancellor, and two days ago this latest addition to one of the most renowned institutions in the world was opened by a short ceremony by the new Chancellor, Lord Rayleigh, whose arms appear over the portal. It is appropriate that the first official act of the new Chancellor should be to declare open a building which his generosity alone has enabled the University to erect.

Owing to the room in which the Chancellor spoke being of limited dimensions, the number of those present at the actual ceremony was not large, but after the ceremony Prof. and Mrs. Thomson entertained a large company of guests at a reception. There was an interesting exhibition of scientific experiments and apparatus by students working in the laboratory.

New Wing of the Cavendish Laboratory, Cambridge. Elevation to Free School Lane.

## *LANDSLIP AT LYME REGIS.*

AN extensive landslip occurred at Lyme Regis on June 10, and was the occasion of many more or less inaccurate paragraphs in the daily papers. The account which was published in the *Western Morning News* of June 12 was, however, fairly full and accurate, being based upon information given by Mr. A. C. G. Cameron, late of the Geological Survey, and now resident at Uplyme. From this and from some additional particulars supplied by the same observer, we are able to state what really occurred on and previous to the date mentioned.

It is needless to say that no volcano or any kind of volcanic action is concerned in the phenomena. Spontaneous combustion took place at one spot on the cliff east of the town, owing, doubtless, to the decomposition of iron pyrites and the rapid oxidation of the iron. As some of the shales contain lignite, and others may be more or less bituminous, the conditions are favourable to the continuance of combustion, and the mound of smoking shale has been an object of great local interest from January to the present time. There is, however, no connection between it and the recent landslip.

The slip took place about 2 p.m. on June 10 below the road which leads from Lyme to Charmouth. The ground here consists of Greensand in the upper part, and of Lias shales in the lower part, the latter forming a succession of cliffs and terraces from a height of about 300 feet down to the beach. There are three tiers of cliffs, and it is the middle one for a distance of about 500 yards (rather more than a quarter of a mile) which is the scene of the slip. A great slice of this cliff suddenly gave way, and slid into the sea with a loud rumbling noise, and the production of semi-circular waves in the water. The slice intersected the mound of burning clay, and Mr. Cameron states that the interior of the mound thus disclosed resembled an old brick-kiln, from the baked appearance of the clays and shales. Falls from the cliffs continued all the afternoon, and the whole range of cliff is still in an unstable condition.

With regard to the cause of the landslip, it is somewhat remarkable that the fall should have occurred during a spell of dry weather, and not after heavy rain. This fact points to some other cause than rain or springs, and such a cause exists in the practice of digging out and taking away the cement-stones and layers of limestone which occur in the lower part of the cliffs. The abstraction of these must have weakened the cliff above, and have caused the cracks which have long been apparent in it; water issuing from the base of the Greensand would find its way into the cracks, and would still further loosen the cohesion of the masses. Finally, the dry weather caused contraction and widening of the cracks, with the result above described.

## *BRITISH COTTON CULTIVATION.*[1]

ABSTRACTS of a series of reports by Prof. W. Dunstan, F.R.S., Director of the Imperial Institute, on the quality of cotton grown in British possessions have been issued as a Parliamentary paper, which gives details with regard to the progress made in cotton cultivation in various parts of the Empire, other than India and Egypt, during the past two years. As instructive as the actual abstracts are brief statements prefixed to each, wherein the present position of cotton cultivation in the colony or protectorate referred to is reviewed.

It appears that the export of cotton from Cyprus, the only European possession dealt with, was much the same for 1905–6 and 1906–7, but that the figures for these years were more than double the figures for 1904–5.

As regards our East African possessions, the exports of cotton and cotton-seed from the Sudan during 1906 reached a total value of more than 45,000*l.*, as against some 23,000*l.* for 1905. From the East African Protectorate the exports during 1906–7 were valued at 1400*l.*, as against 1273*l.* for 1905–6 and 285*l.* for 1904–5. The increased export from Uganda was more marked, the figures for 1906–7 being more than 390,000 lb., valued at 11,400*l.*, as against 96,000 lb., valued at 1089*l.*, for 1905–6, and 21,566 lb., valued at 236*l.*, for 1905. From Nyasaland the exports for 1906–7 were 526,119 lb., valued at 15,345*l.*, a slight decrease on the figures for 1905–6, which were 776,621 lb., valued at 16,180*l.*, but a marked increase on those for 1904–5, when 285,185 lb., worth 5941*l.*, were exported.

As regards West Africa, we learn that exports of cotton from Gambia have ceased; the inhabitants will not take up cotton cultivation, the ground-nut industry being more profitable. The exports from Sierra Leone in 1906 were 87,800 lb., valued at 1829*l.*, as against 68,800 lb., worth 509*l.*, in 1905. A similar increase is recorded from the Gold Coast, whence the exports in 1906 were 92,886 lb., worth 1022*l.*, as against 29,200 lb., valued at 516*l.*, in 1905; also from Lagos, whence in 1906 the quantity exported was about 2,440,000 lb., worth 40,000*l.*, as against 1,281,000 lb., valued at 25,000*l.*, in 1905. On the other hand, the exports from southern Nigeria in 1905 only reached 85,000 lb., as against 285,000 lb. in the preceding year. In Lagos it is stated there are large areas suitable for cotton-growing, but the transport difficulties are great.

The reports dealing with the South African colonies show that Rhodesia and the Transvaal are capable of yielding cottons of excellent quality, and that experimental cultivation in the Orange River Colony, in Cape Colony, and in Natal has given results sufficiently encouraging to warrant further trial. Difficulties with regard to labour and to transport will, however, have to be overcome before an industry can be established. The reports regarding Seychelles and Mauritius indicate that much the same conditions obtain there as prevail in South Africa.

The reports from Asia refer to the Straits Settlements, where the climate is said to be not altogether favourable to the industry, and British North Borneo, where the conditions are expected to be favourable, and there is an ample supply of labour though the exports are small.

As to the Australian colonies and New Guinea, we learn that there are extensive districts in which the soil and climate are suitable for cotton cultivation, but that considerable difficulty is experienced with regard to the supply of labour.

The reports from our American possessions show that in British Guiana the industry is insignificant, and, small as it is, shows a steady falling off. In British Honduras, though the conditions are otherwise favourable, there is a lack of efficient labour; and in Bermuda, owing to the high price of land and labour, it is unlikely that a profitable industry can be established. But the exports from the West Indies show that cotton-growing is there being rapidly extended under the guidance of the Imperial Department of Agriculture, directed by Sir Daniel Morris. The estimated value of the exports of cotton and cotton-seed for 1905 was more than 63,000*l.*; for 1906, more than 90,000*l.*; for the half-year ending June 30, 1907, more than 167,000*l.*

One of the general conclusions on which Prof. Dunstan insists is that in most cases, and especially in West Africa, the best chances of success lie in the improvement of native cottons rather than in the introduction of foreign cottons; another is that every encouragement and facility should be given to the improvement of native cultivation. It is pointed out that the extent to which cotton-growing will be resorted to by native cultivators must depend largely on the price which can be offered by cotton-buyers, and on the competition of other occupations and other agricultural crops.

[1] Colonial Reports—Miscellaneous. No. 50, British Cotton Cultivation. Reports on the Quality of Cottons grown in British Possessions. By Prof. Wyndham Dunstan, F.R.S., Director of the Imperial Institute. (Cd. 3997.) Price 2½*d.*

## *NOTES.*

THE council of the London Mathematical Society has awarded the De Morgan medal for 1908 to Dr. J. W. L. Glaisher, F.R.S., for his researches in pure mathematics.

THE Belgium Academy of Science, Literature, and the Fine Arts has elected Sir James Dewar an associate in the section of mathematical and physical science.

THE inaugural meeting of the Research Defence Society will be held at the house of the Royal Society of Medicine, 20 Hanover Square, W., to-morrow, June 19, at 5 o'clock. The Earl of Cromer, president of the society, will occupy the chair.

THE executive committee and science committee of the Franco-British Exhibition are issuing invitations for a reception to be held in the Science Court of the exhibition on Tuesday, June 30.

AN exhibition will be held at Faenza from August 15 to October 15 to commemorate the third centenary of the birth of the Florentine physicist, Evangelista Torricelli. The exhibition will include international sections for meteorology and terrestrial physics, ceramics, and agricultural machinery. Prizes will be offered for competition in the two first-named sections. Inquiries should be addressed to Conte Cav. Carlo Cavina, president of the executive committee, at Faenza.

A monument to the memory of Boucher de Perthes was unveiled at Abbeville on June 8. Boucher de Perthes, who made important discoveries in prehistoric anthropology in the neighbourhood of Abbeville, died there in 1868. In 1832 he found at Thuison, near Abbeville, the first stone engravings, and in 1863, in the Moulin Quignon cave, the remains of Quaternary man with flint axes. The collections made by Boucher de Perthes were bequeathed to the State, and are preserved in the Museum of Saint-Germain-en-Laye.

The American Association for the Advancement of Science will devote a day during its meeting at Baltimore to the celebration of the centenary of the birth of Charles Darwin and the jubilee of the publication of the "Origin of Species." The programme includes, according to *Science*, arrangements for an introductory address by Prof. T. C. Chamberlin, of the University of Chicago, president of the association, and a number of discourses by American biologists and others. Among the latter we notice that Prof. E. B. Poulton, F.R.S., will speak on natural selection from the point of view of zoology.

A Reuter message from Auckland states that a remarkable volcanic outburst began in the island of Savaii, in the Samoan group, on May 10. The flow of lava was the greatest in the history of the island. It amounted to between 2000 and 3000 tons a minute, and streamed down in a great river from 6 inches to 6 feet deep, stretching in an almost continuous sheet over a width of eight miles. On reaching the coast it flowed over the cliffs into the sea, causing steam to rise in great quantities. The lava destroyed many native houses, and for a time threatened the town of Matatua.

At the General Conference on Weights and Measures, held at Paris in October last, a resolution was unanimously passed urging the universal adoption of a metric carat of 200 milligrams as the standard of weight for diamonds and precious stones. This proposal, which received a large measure of support on the Continent, especially in France, Germany, Spain, and Belgium, was brought under the notice of the principal diamond dealers in this country by the Board of Trade early in the present year, but it has not met with a favourable reception from the trade, and unless the proposed new standard is generally adopted abroad it is unlikely that any further action in the matter will be taken by the Government. The French Ministry is now introducing a Bill to legalise the "metric carat" of 200 milligrams in that country, and to prohibit the use of the word carat to designate any other weight. A recent resolution of the Bombay Chamber of Commerce shows that the proposal for an international standard carat is receiving favourable consideration in India.

The ninety-first annual meeting of the Société Helvétique des Sciences naturelles will be held from August 30 next to September 2 at Glaris. A provisional programme states that at general meetings on August 31 and September 2 the following addresses will be delivered:—Prof. K. Schröter, of Zurich, on an excursion to the Canary Islands; Prof. H. Schardt, of Montreux, on the great erratic boulders of Monthey and neighbourhood; Prof. A. Riggenbach-Burckhardt, of Bale, on gravity measurements of the Swiss Geodetic Commission; Prof. Ch. E. Guye, of Geneva, on the electric arc as a powerful aid to science and industry; Dr. H. Greinacher, of Zurich, on radio-active substances; and Prof. R. Chodat, of Geneva, on Palæozoic ferns, their significance in modern plant palæontology. September 1 will be devoted to sectional meetings and to the annual meetings of the Swiss Geological, Botanical, Zoological, and Chemical Societies. A more detailed programme of the meetings will be available in July.

The Sunday Society, which exists to obtain the opening of museums, art galleries, libraries, and gardens on Sundays, has been making attempts, though as yet unsuccessfully, to secure the opening on Sundays of the science and art collections at the Franco-British Exhibition. The experience gained during the last twelve years would appear to show that the Sunday opening of national museums and galleries has been greatly appreciated, and that there has been no abuse of the privilege. The last published returns show that in 1906 the number of Sunday visitors to the British Museum was 57,738, an average Sunday attendance of 1110; at the Natural History Museum for the same year the corresponding numbers were 61,151 and 1176. In 1905 the number of visitors to the Victoria and Albert Museum on Sundays was 93,005, an average Sunday attendance of 1755; the corresponding numbers in the same year for the Bethnal Green Museum were 74,990 and 1415.

On Saturday last Mr. E. W. C. Kearney gave a demonstration of his high-speed railway system in the temporary building on the east side of Aldwych. Mr. Kearney runs his car upon a single rail, supporting it upon a two-wheel bogey at each end. Above the car there is a second rail engaging a second two-wheel bogey at each end. The upper and lower bogeys are carried upon the same shaft, and so turn together. The intention is to run out of the ground-level stations down an incline of 1 in 7 until a speed possibly of 200 miles per hour is attained, then along the level, and so up to the next station. If this could be done safely and successfully, then, without question, much time would be saved; but nothing which was said or demonstrated on Saturday with the help of a scale model about one-fifteenth the full size in any way made it evident that this would be the case, or that the great economy in first and in running cost claimed would be attained in practice. While the steep declivity would be convenient in the case of tube railways, it hardly meets the requirements of elevated or of long-distance railways, for which the motors would have to provide the whole acceleration. Might it not be well to revive the old brachistochrone problem which the brothers Bernoulli invented before its time and travel on cycloidal routes from place to place? Even Mr. Kearney would find it difficult to compete with this.

After four months' canvassing among metal manufacturers and users, and two preliminary meetings held in Manchester, a new technical society called "The Institute of Metals" was formed at a meeting held at the Institution of Mechanical Engineers, Westminster, on Wednesday, June 10. Sir William White, K.C.B., F.R.S., who occupied the chair, has been for some years the chairman of the Alloys Research Committee, instituted by that body, which has concerned itself to some extent with the non-ferrous metals and their alloys. The following resolution was, after some discussion, adopted unanimously:—"That in view of the widely recognised need for a medium of communication for the advance of knowledge in connection with the production, manufacture, and use of the non-ferrous metals and their alloys, a society to be called 'The

Institute of Metals' shall be and is hereby constituted." Sir William White was unanimously elected the first president, and an interim council, composed of prominent metal manufacturers, ship-builders, marine and locomotive engineers, electric cable constructors, &c., and including representatives of pure science, was appointed to take the necessary steps to bring the institute into working order. The joint hon. secretaries are Prof. H. C. H. Carpenter, the University, Manchester, and Mr. W. H. Johnson, c/o Johnson, Clapham and Morris, Ltd., Manchester. Promises of support have been received from more than 200 persons.

The late Dr. Oswald Seeliger, professor of zoology in the University of Rostock, whose death in his fifty-first year has just been announced, was well known for his many valuable contributions to knowledge, and particularly for his writings on the morphology of the Tunicata. The articles on this group in Bronn's "Klassen und Ordnungen" and in Brehm's "Thierleben" were from his pen. The researches with which his name is most familiarly associated are upon questions connected with the process of budding in Tunicata, Cœlenterata, and other animals. His statement that the nervous system of the ascidiozooids of Pyrosoma is derived from the mesoblast of the parent Cyathozooid, undermining, as it seemed to do, the theory of the germ layers, gave rise to a long and interesting controversy. More recently he repeated Boveri's famous experiment of fertilising the enucleated egg of one species of Echinoderm with the spermatozoon of another, and, like Delage and others, came to the conclusion that the hybrid thus produced does exhibit some of the maternal characters, and that, in consequence, the theory that the hereditable characters are alone borne by the nuclei of the germ cells is untenable. Seeliger's writings were clear and forcible, and as he was free from the ordinary prejudice of orthodox opinion in biological matters, his loss to science is severe.

The second part of the Memoirs of the National Museum, Melbourne, is devoted to a monograph of the Silurian bivalve molluscs of Victoria, in the course of which the author, Mr. F. Chapman, palæontologist to the museum, describes and figures a number of new species.

With the June number *British Birds* commences its second volume, to which we wish every success. To that number Mr. W. H. Mullens commences a series of articles on the older British ornithologists, the first name on the list being that of William Turner, who was born just about 400 years ago, and was therefore a contemporary of the founder of Caius College, Cambridge. Previous to Turner's time, exact knowledge of British birds was practically *nil*, while ornithology was but little more cultivated on the Continent. Turner was the author of no fewer than thirty-nine works, among which the most famous is that dealing with the birds mentioned by Aristotle and Pliny. To this wonderful work may be attributed the rise of British ornithology.

We have received a separate copy of a paper by Messrs. Huene and Lull, from the February number of the *American Journal of Science* (vol. xxv., p. 113), on the Triassic reptile *Hallopus victor*, which was regarded by its original describer, the late Prof. O. C. Marsh, as a theropod dinosaur. In some respects the pelvis is, however, more like that of an orthopod dinosaur, although in the form of the pubis, the calcaneum, the extreme thickness of the astragalus, the contour of the scapula, and the height of the ilium, the skeleton differs from all known members of that group. In the opinion of the authors (the grounds of which are promised in a later memoir), the genus appears to be most nearly related to Aëtosaurus and its allies.

To the April number of *Spolia Zeylanica* Commander Boyle Somerville communicates a thoughtful paper on the submerged plateau surrounding Ceylon at an average distance of about a dozen miles from the coast, with depths shoaling from south to north from 40 to 20 fathoms. Everywhere there is a sudden drop to oceanic depths on the outer margin, but a slightly deeper channel or gully occurs in the centre, tapering off to the northward and ending in a marked shoaling, and the existence of banks, which begin at Mount Lavinia and extend northward. After referring to the occurrence of lakes or lagoons near the coast nearly all round the island, the author concludes that while the high-ground of Ceylon has existed as land for an extremely long period, the low-country has in the main been formed by the denudation of the central elevated area, and was laid down on a plateau of which the present fringe is a remnant. This accounts for the absence of coral reefs round most of the coast.

Stone implements from the Bulawayo district form the subject of an illustrated paper by the Rev. F. Gardner in vol. vii., part i., of the Proceedings of the Rhodesia Scientific Association. The account is based on the large collection in the Rhodesia Museum. Many of the implements are of well-defined shape and show workmanship of a high order, although not rising to the standard frequently noticeable in their corresponding (Neolithic) European prototypes. In the author's opinion, they represent a mixture, and are the product of many ages, some, perhaps, having been manufactured in quite recent times.

The latest issue (vol. iii., No. 1) of the *Journal of Economic Biology* is devoted to an investigation, by Miss J. S. Bayliss, of the basidiomycetous fungus *Polystictus versicolor*, that grows as a saprophyte on dead wood, causing it to rot and crumble. The bracket-like fruiting body is characterised by a velvety zoned upper surface. In laboratory cultures spore sowings produced oidia and conidia, and on infected blocks of wood incipient fruiting bodies were produced, but full development was only obtained when the blocks were exposed under natural conditions. Similarly, it was observed that the sporophores will not develop in the dark or when revolving on a clinostat. The zoning is shown to be due to changes in the rate of growth dependent upon the temperature of the air and the amount of moisture present.

The botanic station in St. Vincent occupies a portion of the site of the old botanic garden, established in 1765, that reached a high state of prosperity during the tenure of Dr. Anderson as superintendent. The station was re-established by Mr. H. Powell in 1890, who with the present curator, Mr. W. N. Sands, has contributed to its present standard of efficiency. A historical account, accompanied with reproductions of photographs taken in the gardens, appears in the annual report for 1906–7. Conditions in recent years have led to a remarkable increase in cotton cultivation, and a great reduction in the area devoted to sugar-cane. Arrowroot still supplies the most valuable asset of the colony, but the value of the cotton exported will shortly exceed that of the former product.

Two Bulletins received from the University of Illinois afford evidence of the value of the investigations carried on by the Engineering Experiment Station. Prof. A. N. Talbot (Bulletin No. 20) gives the results of tests of concrete and reinforced concrete columns, throwing light on the properties of plain and hooped concrete. The additional strength of the hooped column over that for an unreinforced column of the same quality averages for each 1 per cent. of hooping 955 lb. per square inch for spiral hooped columns and 669 lb. per square inch for band-hooped columns having a diameter of 12 inches. Tests of a liquid-air plant are recorded by Mr. C. S. Hudson and Mr. C. M. Garland (Bulletin No. 21). The tests were made for the purpose of determining the most economical conditions for operating the liquid-air plant belonging to the University.

We have received from the Rev. O. Fisher a letter commenting on the distinction drawn by Mr. R. D. Oldham between "earthquakes" and "earthshakes" in a communication published in the issue of Nature for May 28. Mr. Oldham on that occasion wrote:—"We may say that earthquakes, or at any rate severe earthquakes, are frequently, if not invariably, caused by rupture of the earth's crust and the formation of fractures or faults in the solid rock, but these fractures, which are the primary cause of the earthquake, are only the secondary result of the earthshake, the action of which arises at a greater depth, and the ultimate cause of which lies beyond our present ken" (vol. lxxviii., p. 78). Mr. Fisher read this to imply that Mr. Oldham applied the term "earthshake" to the deep-seated cause of the "snap and jar" caused by a rupture of the rocks, which gives rise to the vibratory movement constituting an earthquake, and suggests, as more probable, that the deep-seated cause is of the nature of an accumulating stress, which goes on increasing until the crust gives way suddenly, producing the "snap and jar" which produces world-shaking results. "What we want," says Mr. Fisher, "is a term to express the molar displacement of the ground as distinguished from the vibratory." Mr. Oldham informs us that in reality he is in agreement with Mr. Fisher. "The word earthshake," he writes, "was not intended to apply to the slowly accumulating stresses, but to the molar displacements accompanying the abrupt relief of the strain induced by these stresses." Mr. Oldham says "it might have been better to have suggested a wholly new word, such as bathyseism, carrying with it no connotation of meaning, but so many 'seisms' have already been suggested, and so loosely used, that I was chary of inventing yet another."

We have received from Prof. H. Mohn two valuable publications relating to the meteorological service of Norway for the year 1907:—(1) the year-book, containing complete observations or results at sixty stations, and (2) rainfall observations, containing daily measurements at 200 stations, with monthly or yearly amounts at a much larger number of places, for some of which the results are quoted so far back as 1867. These publications have been issued in the same excellent form for many years, and the data are of exceptional importance, due to the exposed position and topographical features of the country.

The report of the observatory department of the National Physical Laboratory for the year 1907 shows that the only very large magnetic disturbance was that of February 9–10, already referred to in Nature (February 14, 1907, vol. lxxv., p. 367); the mean declination for the year was 16° 23′ W. The largest seismological disturbances recorded took place on April 15 (the Mexican earthquake), maximum amplitude, 15 mm., September 2, and December 30. The lowest temperature, 23°·3, occurred on January 27, and the highest, 77°·7, on September 25; the total rainfall was 23·85 inches. The verification of instruments (exclusive of watches and chronometers), one of the most active branches of the useful work of the observatory, again shows a large increase, the total number of instruments tested being 34,700, or 5133 more than in the previous year, and was chiefly due to increased numbers of clinical and ordinary thermometers. A large part of the time devoted to experimental work has been occupied by observations on atmospheric electricity and on solar radiation.

In *Engineering* of June 5 there is an illustrated article on electric iron and steel furnaces, in which the leading types are described. At the present time, electric iron smelting is still in its infancy, while electric melting and refining furnaces have been added to many notable works. There is a good deal of electric melting, but, so far, little smelting. The reasons are not far to seek. All furnaces are wasteful; the electric furnaces do not form an exception, and electricity is not inexpensive, whether generated by water-power or by coal. The advantages of water-power have been much over-rated. When water-power begins to develop, it becomes subject to rates and taxes. Hydro-electric installations are by no means simple. The water may fail in summer owing to drought and in winter owing to frost, and reserve steam-power has to be provided; if a good load-factor is to be maintained, the reserve must be of ample capacity. Manufacturers are, moreover, becoming sceptical as to the advantages to be gained by installing works close to the mines and to the waterfalls, so as to secure cheap power and to avoid the transport of ores. The power item is not, as a rule, the decisive factor, and the crude ore transport may, after all, prove economical.

The practical value of the fascinating study of diatoms as a test of the powers of the microscope is illustrated by a note on *Biddulphia mobiliensis* contributed to the April Journal of the Royal Microscopical Society by Mr. Edward M. Nelson. The secondary structure of this diatom is so delicate that Mr. Nelson was unable to draw or even retain the image for any length of time, and in pointing out that the secondaries have only been seen with long-tube microscopes, the author states as his conclusion that "the ultimate appeal concerning any very minute structure must go to a long-tube microscope."

Prof. H. Fehr, editor of *L'Enseignement mathématique*, has reprinted from that journal the results of his inquiry on the work of mathematicians. It will be remembered that some time ago a circular was addressed to mathematicians containing thirty questions regarding their habits of life, the way in which they acquired an interest in mathematics, the advice they would give to a young mathematician, and other matters of a personal character. The classification of the answers has been undertaken by Profs. Th. Flournoy and Ed. Claparède, of the psychological department of the University of Geneva. Perhaps the diversity of the answers is one of the most noticeable features of the inquiry.

A new periodical entitled *Popular Electricity* has just been issued by the Electricity Publishing Co., of New York. The first number—for May—consists of thirty-six well illustrated pages dealing with such subjects of general interest as electric lighting in the house, how to read an electricity meter, the new metallic filament lamps, &c. The language is free from technicalities, and the treatment humorous on occasions. It would be interesting to know how far the electric milking machine and the electric shoeblack described are commercially successful in America.

THE March number of *Terrestrial Magnetism and Atmospheric Electricity* contains an article by Dr. L. A. Bauer on the question of the exact nature of the action of the earth on a magnet, which, according to our present ideas, should reduce to a couple. Most careful and accurate weighings of a magnet with its axis pointing in various directions have been made on a balance specially constructed to be free from magnetic material, and show that on the average for stations in Alaska, British Columbia, Kansas, Maryland, and Washington, the weight when the south pole of the magnet was to the north exceeds that when the magnet is reversed by 1 part in 1,000,000. In disturbed regions the differences of weight observed exceeded 1 part in 100,000. Preliminary experiments on the influence of magnetisation on the weight of a magnetisable material show an increase of the order of 1 part in 1,000,000 on magnetisation.

THE Transactions of the English Ceramic Society for the session 1906–7 show that a great deal of active experimental work is being done by members of the society, and that very considerable progress is being made, with the aid of scientific method, in elucidating obscure points in pottery work. A number of useful investigations are described in the Transactions, of which a few may be referred to as possessing more than a purely technical interest. Mr. Page contributes a paper on the properties of refractory clays, dealing principally with the connection between chemical composition and fusibility; Dr. J. W. Mellor and Mr. F. J. Austin have examined the changes in the microscopic character of various types of refractory substances when subjected to prolonged heating; and Dr. Mellor deals at length with the behaviour of pyritiferous clays on weathering and when heated. The members of the society are to be congratulated on the work they are doing in extending our knowledge of a very difficult subject.

AN eighth edition of "A Treatise on Qualitative Analysis and Practical Chemistry adapted for Use in the Laboratories of Colleges and Schools," by Dr. Frank Clowes, has been published by Messrs. J. and A. Churchill. The present edition has undergone revision mainly in the section on the preparation and detection of gases, and in sections dealing with the reactions and detection of organic substances.

IN Prof. D'Arcy Thompson's paper "On the Shapes of Eggs" in NATURE of June 4, the formula on p. 113 should be $p_n + \frac{T}{r} + \frac{T'}{r'} = P$, and in paragraph 13 the words "the egg is invariably spherical" should be "the yolk is invariably spherical." The first word on the penultimate line of this paragraph should also be *yolk* and not *egg*.

## OUR ASTRONOMICAL COLUMN.

ENCKE'S COMET, 1908*b*.—According to the ephemeris given by M. Kamensky in No. 4241 of the *Astronomische Nachrichten*, the southerly declination of Encke's comet is increasing, and the comet is apparently travelling rapidly through the southern constellations Sculptor and Grus towards Indus. Its position on June 21 will be

$$\text{R.A.} = 24\text{h. } 0\text{m., dec.} = -41^\circ\ 25'.$$

From an announcement in No. 4252 of the same journal (p. 71, June 3) we learn that the position determined by Mr. Woodgate, at the time of re-discovery on May 27, gave corrections of +5m. 22s. and −33′ to the ephemeris.

A FOURTH MINOR PLANET NEAR JUPITER.—Elements calculated by Dr. Ebell for the orbit of the minor planet 1908 C.S. indicate that this object belongs to the Achilles group of asteroids, which travel in orbits near to that of Jupiter. This makes the fourth member of this group to be discovered (the *Observatory*, June, p. 257, No. 397).

OBSERVATIONS OF JUPITER'S EIGHTH SATELLITE.—A note by Prof. E. C. Pickering, published in No. 4253 of the *Astronomische Nachrichten* (p. 87, June 5), states that, according to a telegram from Prof. Campbell, the eighth satellite of Jupiter was observed by Prof. Perrine, at the Lick Observatory, on April 1 and 29. The last observation at Greenwich was made on April 24, so that Prof. Perrine's second observation will serve to extend the path already observed, and will provide a useful check on the ephemeris calculated from the results of the Greenwich observations.

PHOTOGRAPHIC DETERMINATION OF STAR COLOURS.—In No. 3, vol. xxvii., of the *Astrophysical Journal* (April, p. 169) there is an interesting paper by Messrs. Parkhurst and Jordan, of the Yerkes Observatory, on the photographic determination of star colours and their relation to spectral types. The method employed is based on that suggested by Schwarzschild, in which it is assumed that a satisfactory measure of a star's colour may be obtained by comparing the visual magnitude of the star with the magnitude derived from photographs taken on ordinary plates, but the present workers have modified it by determining the "visual" magnitudes by photographic means. With this object in view, they regularly exposed pairs of ordinary ("Seed") and "Pan-iso" plates, the latter giving the "visual" magnitude. Their results show that this method furnishes a simultaneous comparison of the visual and photographic magnitudes of a star freed from most of the uncertainties of ordinary visual methods. As the colour intensities thus derived correspond, in general, to definite spectral types, this procedure furnishes a method of determining the spectra of stars which are too faint for the ordinary spectrographic method.

THE MAXIMUM OF MIRA IN OCTOBER, 1907.—During the period July 13, 1907, to March 9, 1908, Prof. A. A. Nijland made a series of observations of the magnitude of Mira, and in No. 4253 of the *Astronomische Nachrichten* (p. 79, June 5) he publishes the results obtained. These show that the maximum (mag. 3·25) was attained on October 30, 1907 = J.D. 2417879. The four last maxima observed are compared, as regards their dates, with the ephemeris published by Dr. Guthnick, and the differences (O–C) are thus shown to be +2, −19, −13, and −16 days respectively. The magnitudes at maximum range from 3·9 (J.D. 2417214) to 2·0 (J.D. 2417552), and the periods between the four most recently observed maxima, are shown to have been 310, 338, and 327 days respectively.

DETERMINATION OF LONGITUDE DIFFERENCE.—Bulletin No. 130 from the Lick Observatory describes the recent determination of the difference of longitude between the Lick and Mare Island Observatories, carried out by Messrs. Tucker and Sanford during April. The difference determined was 2m. 30·74s., with a probable error of ±0·01s., and, accepting that of the Lick Observatory as 8h. 6m. 34·81s. W., this gives the longitude of the Mare Island Naval Observatory as 8h. 9m. 5·55s. W.

CORONAL STREAMERS.—In No. 4, vol. xxvii., of the *Astrophysical Journal* (p. 286, May), Prof. J. A. Miller describes a method whereby it becomes possible to determine the heliocentric position of a certain class of coronal streamers. The streamers discussed are those which first curve away from, and then towards, the projection of the pole of the sun, or *vice versâ*. Applying his method to the discussion of such a streamer, shown on the photographs taken by Prof. Cogshall and himself in Spain in 1905, he finds the latitude and longitude of the point from which the streamer matter was projected, and also shows that the force of repulsion is so nearly equal to the attraction of the sun (the ratio being as 0·99 : 1·0) that the particle considered had probably been ejected some 251,860 seconds—or about seventy hours—before the eclipse occurred. At the time of the eclipse this particle was at the point of the streamer, where it reversed its direction of curvature, and was about 1·3 radii of the sun from its centre.

## LOW TEMPERATURE GALVANISING.

THE coating of iron with zinc in order to protect it from atmospheric corrosion is an industry which dates back to 1846, and is employed upon a very large scale. The original process, and still the chief one in vogue, was to dip the cleaned iron surface into a bath of molten zinc. The zinc forms an alloy upon the surface of the iron, and as zinc is very little acted upon by the atmosphere, whereas iron rapidly rusts and corrodes, a protective coating is obtained. Furthermore, in the case of tanks, buckets, &c., it is not necessary that the joints should be absolutely water-tight, because when dipped into the molten zinc any slight leaks are filled in with this metal.

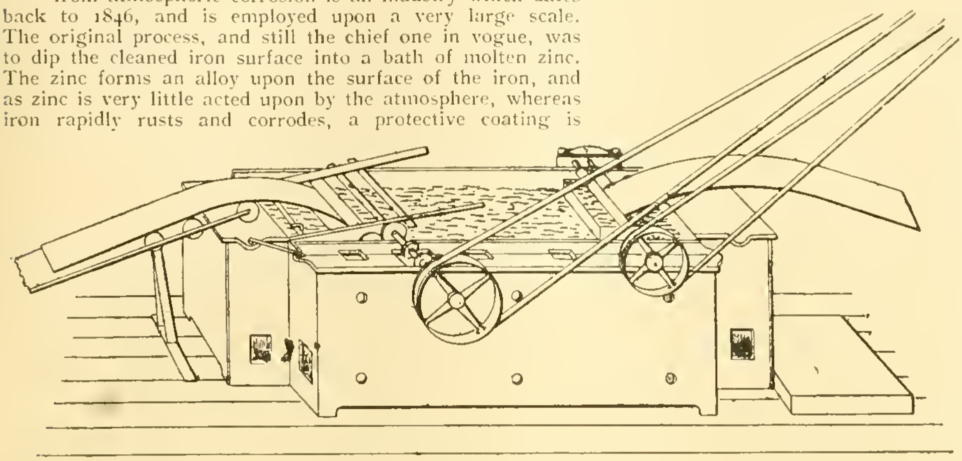


FIG. 1.

The great advantage of employing zinc as a coating for iron is that it is electropositive to this metal, and thus the tendency is for the zinc to go into solution and become oxidised, instead of the iron with which it is in contact being acted upon. The zinc, however, takes on a protective coating of oxide or oxycarbonate, and thus further corrosion is prevented, or at any rate will only take place very slowly.

There are, however, disadvantages in connection with hot galvanising. In the first place it is expensive to keep large quantities of zinc in the molten condition. Secondly, there is considerable loss of zinc through oxidation. Thirdly, the zinc tends to alloy with the iron and to form a difficultly fusible alloy. The higher the temperature of the bath the greater the tendency for alloy formation, but, on the other hand, the thinner the coating obtained upon the metal to be galvanised, and thus in this direction a saving in cost. The alloy of iron and zinc produced is extremely hard, and is sometimes used for making bearings, but as it is difficult to separate the iron from the zinc it is a distinct disadvantage to the galvaniser. Finally, the hot zinc is apt to destroy the temper of the iron, and sometimes to distort the shape of the article to be galvanised.

Consequently, it is necessary to keep the bath at as low a temperature as possible, the excess of zinc being removed by passing the sheets through rollers (Fig. 1).[1]

Cold galvanising or electrolytic galvanising has therefore been suggested, and is actually employed for specific purposes, but there are a good many reasons which have prevented it coming into general use. In the first place, the articles to be galvanised require a more thorough cleansing than is the case with hot galvanising, the least trace of grease being fatal to a good deposit. If there happen to be flaws or the joints are not quite tight, these are not filled in by the wet galvanising process. There are also difficulties in connection with the use of zinc anodes owing to disintegration. As a rule, therefore, lead or iron anodes are employed, and the strength of the electrolyte is maintained constant by circulating it through a filter bed consisting of coke and powdered zinc or coke and zinc oxide (Fig. 2). The disadvantage that flaws are not coated by electrolytic galvanising is in certain cases made use of.

For example, steam tubes employed for marine boilers may have slight flaws which are practically impossible to locate by mere inspection, but which, if the tubes were actually used in boiler construction, might lead to very serious accidents. If such tubes are electro-galvanised, the flaws are made apparent owing to the inequality of the galvanising, probably partially produced by local action.

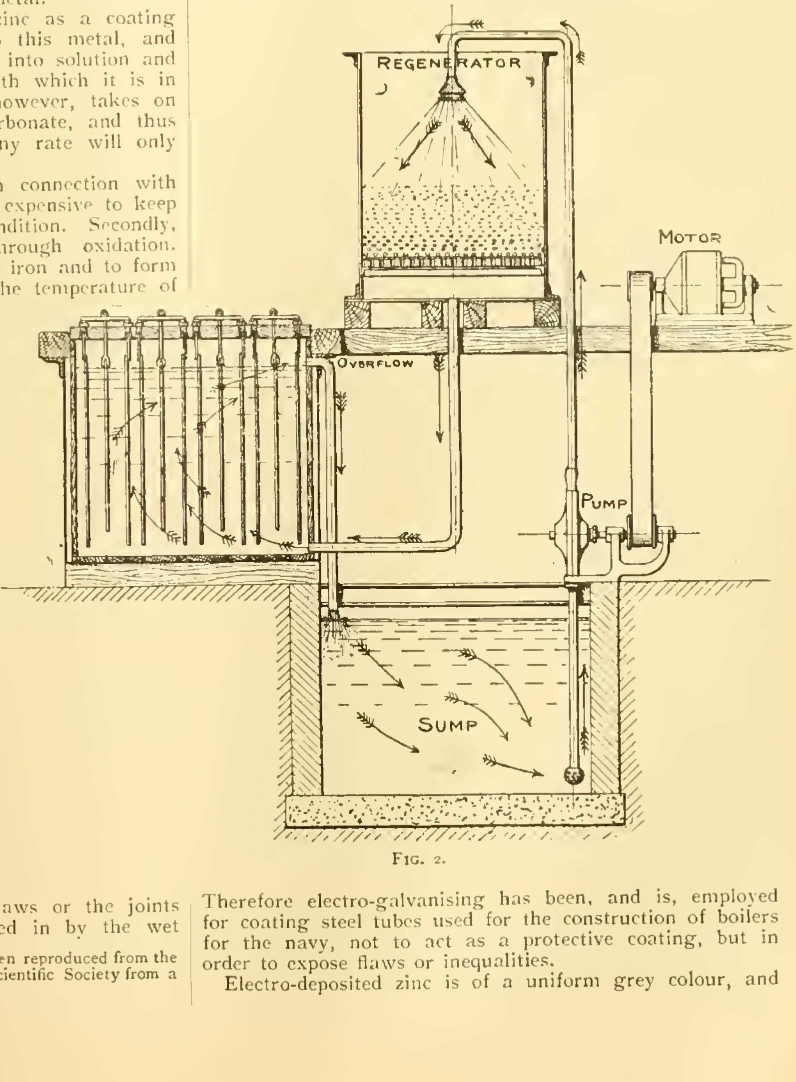



FIG. 2.

Therefore electro-galvanising has been, and is, employed for coating steel tubes used for the construction of boilers for the navy, not to act as a protective coating, but in order to expose flaws or inequalities.

Electro-deposited zinc is of a uniform grey colour, and

[1] The diagrams accompanying this article have been reproduced from the Transactions of the Glasgow Technical College Scientific Society from a paper read by Mr. S. Cowper-Coles.

does not exhibit the artistic crystalline structure produced in hot galvanising. It is very even, and takes on a beautiful polish, so that actually it can be made more artistic than zinc deposited by hot galvanising, which, owing to its crystalline structure, cannot very well be polished.

But beside the actual cold galvanising and the galvanising by means of molten metal, there is a low temperature dry process which was accidentally discovered by Mr. Sherard Cowper-Coles some little time ago. In order to temper certain articles, Mr. Cowper-Coles imbedded them in zinc powder, and they were then heated to a temperature which was considerably below the fusing temperature of zinc. After cooling the articles were taken out, and were, to the surprise of the operator, found to be homogeneously coated with metallic zinc. The zinc was firm and adherent, and on cutting a rod of metal through, it was found that the zinc had penetrated an appreciable depth into the other metal. Experiments were then undertaken to ascertain what was the lowest temperature which could be employed, and whether all metals would thus react with the zinc. It was found that metals could be evenly and completely coated with zinc by heating to a temperature of from 250° C. to 330° C. (zinc melts at 418° C.). The process is now called Sherardising, after the name of the inventor, and is worked essentially as follows:—

Zinc dust, which is obtained as a by-product in the metallurgy of zinc, is the raw product employed. This substance, which amounts to about 10 per cent. of the zinc produced, and can therefore readily be obtained in large quantities, consists of very finely divided zinc mixed with considerable quantities of oxide. Scale and oxide are removed from the articles to be coated; this, of course, is also necessary in all other galvanising processes. In other processes, however, it is also necessary to remove grease, but in this dry galvanising the removal of grease is not necessary, and its presence, at any rate in small quantities, appears to be a distinct advantage. After the scale has been removed the articles are placed in a closed iron receptacle, and the zinc dust charged in; the containing box may be arranged either to work stationarily or rotated. The temperature is then raised to 250° C. to 330° C. by means of gas firing, and maintained so for from half an hour to several hours, depending upon the coating required and the nature of the article to be coated. The drum is then allowed to cool, and discharged. Owing probably to the individual grains of zinc in zinc dust being coated with oxide, it is a very difficult matter to cause it to melt together even when the temperature is raised far above its melting point. This is one of the troubles met with in the metallurgy of zinc, that is, there is a tendency for the metal to condense as dust and not to run together and liquefy. But in the Sherardising process this is a distinct advantage, because, should the drum become overheated, there will be no danger in its melting together and spoiling the articles to be galvanised.

In order, so far as possible, to prevent increase in oxide during heating, the receptacle is preferably made air-tight, but when this is not possible about 3 per cent. of fine charcoal is added to the zinc. Otherwise, as the quantity of oxide increases, the deposit lacks in lustre. The fact that small quantities of grease do not prevent the production of a good deposit is of importance, because it enables machined work, such as bolts, screws, &c., to be placed directly into the galvanising drum without previous cleaning. For small articles, such as screws, rings, nuts, &c., a closed iron cylinder which can be rotated or oscillated is the most suitable form of furnace. For tubes, oblong or cylindrical work, it is most satisfactory to have the door at the end of the furnace, and oscillate it on its axis. A number of Bunsen burners are arranged below the drum, and the whole is enclosed in an iron shell lined with asbestos. For larger work, stationary iron boxes are employed, as illustrated in Fig. 3.

A plant has been erected near London containing four furnaces capable of taking drums 6 feet by 2 feet, with a cubic capacity of two tons of material at one charge. The furnaces are heated with Dowson gas. It is essential that the zinc dust be dry before being added to the furnace, otherwise the zinc is oxidised, and hydrogen is given off on heating.

It is stated that in practice dry galvanised or Sherardised steel and iron will withstand the ordinary corrosive agents to which galvanised ware is usually exposed to a remarkable degree. Even after the apparent removal of the zinc by abrasion, the iron will retain its resistivity.

This resistivity is probably due to the protective action of the zinc-iron alloy formed below the actual zinc coating. The temper of steel wire is not reduced by dry galvanising, owing to the low temperature at which the process is carried out. In Sherardising, the zinc does not form a more or less thick coating or skin, but actually sinks into the metal. As a consequence, the fine lines of screws and other articles which have been machined are not blurred. For example, the minute screws which are employed in making watches can be Sherardised, and fit the holes tapped to receive them quite as well as before being zinced.

In the ordinary method of galvanising it has not been

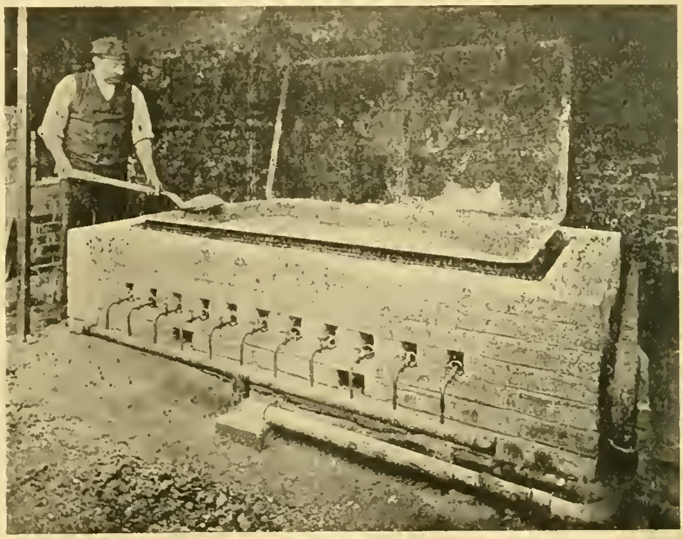


FIG. 3

found possible to produce patterns, because, of course, the whole article has to be dipped, and there are also difficulties in doing this with electrolytic galvanising owing to the electrolyte getting beneath the stopping material which may be used; but with the Sherardising process it has been found possible to produce some very artistic effects. In order to do this, the article is coated with a stopping-off composition. The composition is about the consistency of soap, so that it can be easily cut with a knife. The design is traced with an edged tool, and the portions to be removed are lifted away, so that a clean surface is exposed to the action of the zinc. The object so prepared is placed in an iron drum containing the metal which is to be inlaid in the powdered form, for example, the zinc dust. The galvanising is then carried out as already described.

The temperature and the time which the heating has to be continued are regulated according to the thickness which is required for the inlaying, and may vary from a few minutes to several hours. After inlaying it is found that the part inlaid is much harder than the brass or copper into which it is inlaid.

Furthermore, it is possible to obtain a variety of colours by means of the process. Suppose, for example, one wishes to inlay a copper vase, and convert some parts of it into brass; this can be done by variations in the thickness of the stopping-off composition and by heating to a higher temperature than is generally done. By proceeding in this manner some portions can be converted into yellow-coloured brass, and other parts remain pure copper.

The contrasts between copper and brass are very marked,

FIG. 4.—Copper and brass coal vase inlaid with zinc.

but softer effects can be obtained with zinc, aluminium, tin, and other metals. Fig. 4 shows such an inlaid copper vase.

One beauty about this process of inlaying metals which differentiates it from other processes is the soft transition which shades the inlaid metal from the surrounding metal. For instance, it will be observed that when inlaying zinc into copper, the zinc is surrounded by a halo of the brass-coloured alloy.

Mr. Cowper-Coles has also another process, which he calls Cowperising, and in which he uses vapour of zinc; the articles to be coated are *not* brought into contact with dry or molten zinc, but are placed in a chamber into which zinc vapour is passed. The chamber or drum is slowly rotated inside an outer cylinder in which the metallic zinc is heated by means of a gas or electric furnace. Hydrogen gas is also passed into the apparatus from a tube, and a pilot light is kept burning to make sure that air is not being sucked back.

The process has been found successful for decorating porcelain and metallic surfaces with a brilliant coating of zinc. The remarkable part about the action of zinc powder upon metals is the manner and speed with which it, at temperatures much below its melting point, sinks into and alloys with them. In this, Sherardising rather resembles Sir W. Roberts-Austen's experiment in which he placed pieces of gold and lead together, and showed that diffusion took place even at ordinary temperatures; in his case, however, the diffusion was very slow. But with the Sherardising process the zinc sinks in in a few minutes to an appreciable depth. Another peculiarity is that the zinc does not require to be pure, but is the commercial dust which is coated with oxide, and with this zinc dust I have found that it is practically impossible to get an electric current to pass through even a centimetre thickness, although 100 volts pressure was employed. Cadmium and a few other metals can also be employed, but they are not so satisfactory as zinc.

It looks as if the zinc has a very distinct vapour pressure even a very long way below its melting point, not to say its boiling point. The zinc vapour being immediately able to alloy with the iron or other metal in contact with it, equilibrium is destroyed, and a further portion of the zinc becomes vaporised. F. M. P.

## *STUDIES OF SOME AMERICAN METEORITES.*

THE large crater, three-quarters of a mile across and 500 feet in depth, near Canyon Diablo, in Arizona, which it is supposed was produced by the impact of an enormous meteorite, has already been described at some length in NATURE (1906, vol. lxxiv., p. 490). Since that date the locality has been visited by Dr. George P. Merrill, of the United States National Museum, and in a paper published in the Smithsonian Miscellaneous Collections (1908, vol. l, pp. 461–90, with fifteen plates) he gives the results of his observations, and reviews the evidence for and against the meteoric hypothesis. In the hope of finding a large mass of metallic nickel-iron, Messrs. D. M. Barringer and B. C. Tilghman have made a detailed examination of the crater, and have put down a number of bore-holes to the depth of 1100 feet in its floor. Beneath the surface débris from the sides of the crater there is a thick bed of lake deposits; this lies on a crushed and pulverised sandstone containing fused and pumiceous fragments and particles of nickel-iron, while at a depth of about 600 feet the undisturbed red sandstone of the district was met with. No large mass of meteoric iron was encountered; and with the exception of four small pieces, the numerous masses of Canyon Diablo meteoric iron have all been found outside the crater. All the evidence undoubtedly points to the crater having been formed by the impact of a meteorite.

Prof. O. C. Farrington, in his "Meteorite Studies, II.," published in the geological series of the Field Museum of Natural History (Chicago, 1907), gives a collection of miscellaneous notes respecting nine different meteoritic falls in the North and South American con-

Mass produced by joining the two individuals of the Chupaderos meteorite. × 1/20.

tinents, most of which have been previously described, though one, an iron from Lampa, in Chile, is now described for the first time. The paper is illustrated with fifteen excellent plates of photographic reproductions; special attention may be directed to those representing the large masses of meteoric iron mounted in the School of Mines in the city of Mexico, which, though long known, do not appear hitherto to have been figured. The two masses of the Chupaderos iron, found at a distance of about 800 feet apart, and known in Mexico since 1852, evidently formed part of the same mass, the total weight of which would have been about twenty-one tons. Particulars are also given respecting the fall of stones near Modoc, in Kansas, on September 2, 1905; fifteen stones with an aggregate weight of 35 lb. were found over an area of seven by two miles, the several masses gradually increasing in size from west to east, this being the direction in which the meteor fell. The same distribution of the stones according to size is noted in the fall at Weston, in Connecticut, in the year 1807.

## *THE SCIENCE COURT OF THE FRANCO-BRITISH EXHIBITION.*

All international exhibitions have contributed in some measure to the advancement of science. The assembling before the public of a great array of machinery has from time to time acted as a stimulus to inventions in which science was applied to promote safety, comfort, or luxury. The competition between manufacturers of scientific apparatus, encouraged by medals and other awards of excellence, doubtless resulted in improved workmanship and better design in the tools which the scientific investigator or teacher has to employ. The sporadic display of original or merely antique instruments (*e.g.* clocks) did little more than hint at an evolution of scientific knowledge, and fell far short of exhibiting in any adequately organised manner the actual progress of such evolution, full as it was—and is—alike of human and philosophical interest.

Happily, we need not discuss the causes which hitherto prevented the realisation of an exhibition dealing with all branches of research by scientific experiment; whether the managers of international exhibitions have been deterred by lack of faith in the popularity of a section devoted to purely scientific exploration of the boundaries of knowledge, or by a too vivid realisation of the difficulties attendant upon the formation of such a collection as would worthily represent British achievements in the past and activities in the present. There is no need to debate the matter; visitors to the Science Court of the Franco-British Exhibition can see for themselves the *fait accompli.* Thanks to the initiative of Sir Norman Lockyer, supported by Sir William Mather and the executive committee, and backed with equal heartiness and ability by members of the British Science Guild, for the first time in the history of international exhibitions there has been brought together a collection of exhibits devoted to the illustration of methods and results of scientific research.

As chairman of the Science Section, Sir Norman Lockyer expressed regret that it has not been found possible to organise a French section, and we shall all echo this sentiment the more fully from seeing what an instructive display is contributed by the limited area of Great Britain and Ireland. By its very nature scientific investigation subordinates national rivalry to national cooperation, and anyone may point to the fact that no department could have attained its present state of efficiency had its progress not been furthered by the genius of the *savants* of France.

The catalogue, a closely printed volume of one hundred and ninety pages, has a permanent value for purposes of reference, and is sold for the moderate price of sixpence. No individual critic can do justice to all the departments represented, which are compendiously described as including instruments and methods used in and results obtained from the exploration of (1) the land; (2) the sea; (3) the air; (4) the heavens. Visitors will be impressed with the richness of the collection in apparatus and documents of historic interest, and with the complete subordination of the trading element. To indicate the character of this unique exhibition we give short notes on a few of the interesting features.

*Heat.*—The Manchester Municipal School of Technology lend Joule's laboratory note-books and MS. of researches, and his apparatus used for observing the heat-effects of compression and rarefaction of air. Portraits of Joule and some models of apparatus and reprints of papers are also shown. The physical department of the Imperial College of Science and Technology, South Kensington, exhibits modern appliances used in recent calorimetric, thermometric, and barometric determinations, including sunshine receivers and recorders. One recorder shown registers electrically to 1 part in 10,000 the variations produced in a receiver distant a mile or more. With the platinum grid thermometer for determining the temperature of the air is shown a record obtained during the solar eclipse of August 30, 1905. The Cambridge Scientific Instrument Company show Boys's radiomicrometer, a Féry pyrometer, Callendar and Griffiths's bridge, &c.

It will be seen that we have, on the one hand, the historic apparatus and documents, on the other, the methods and means of up-to-date research. This is typical. All the numerous sections into which the Science Court is divided and subdivided show the same contrast of ancient and modern research. As a consequence, the serious student will everywhere find interesting material, and it may well happen that he will learn more and get fresher views of his subject from the early investigators.

*Magnetism and Electricity.*—This is a strong department, the evolution of telegraphy in all its branches being particularly well illustrated. From the Wheatstone Laboratory of King's College, London, come the original Daniell's batteries, the original resistance box, bridge and chronograph of Wheatstone, while Sir William Preece and H.M. Postmaster-General contribute numerous specimens dating from 1837 to 1908 which present a miniature of progress in the electric transmission of signals. Signor Marconi sends thirty-three items, including some of the apparatus used in Newfoundland for the first Transatlantic reception in 1901. Much of the evolution of the Ayrton-Perry instruments can be traced. The early and recent forms of lamp contributed by Sir J. W. Swan are particularly interesting. It is hardly necessary to say that Kelvin instruments find a place, as do the devices associated with the recent researches of H. A. Wilson, P. E. Shaw, Duddell, and Fleming. Dr. Shelford Bidwell shows his selenium cell, and attention will no doubt be attracted to his model of apparatus for transmitting pictures by telegraph, also dating from 1881.

*Chemistry.*—There is an excellent collection of preparations in connection with both physical and technical chemistry. Recent research is represented by contributions from the Davy-Faraday Research Laboratory, the Imperial College of Science, the University of Manchester, and many institutions and investigators too numerous to mention. Many will doubtless be interested in the apparatus used by Lord Rayleigh in the discovery of argon, and by Sir William Ramsay in his researches on helium and the new gases. The penetration of the physicist into the domain of the chemist is nicely illustrated by the inclusion of Sir Oliver Lodge's "ether machine" in the chemistry division. Magnificent specimens of salts of the platinum group were on view, lent by Messrs. Johnson, Matthey and Co. But of all the items in this division we were most attracted by (1) Black's original balance, dating from 1766—the foundation-stone of modern chemistry; (2) original mauvein preparations made by the late Sir William Perkin between 1868 and 1872. The general public may be expected to be interested in the "oldest lucifer matches," made by Walker, of Stockon-on-Tees, in 1827; also in the "chemistry of a bottle of eau de Cologne," contrasting natural and synthetic methods of production.

*Metallography.*—Micro-sections of metals prepared in 1863–4 by the late Dr. Sorby are shown; the remainder of the items illustrate modern developments of this branch of science, to further which a special institution was founded quite recently.

*Biology.*—The members of the biology subcommittee have secured an exhibit of profound interest from the Liverpool School of Tropical Medicine, which has sent specimens illustrating sleeping sickness, ngana, malaria, yellow fever, bubonic plague, and other terrible scourges. We were glad to see portraits of Major Ronald Ross and other leaders in the campaign which science is waging on behalf of humanity, and especially on behalf of the native races of the tropical regions of the Empire. The evolution of the microscope is excellently demonstrated by the instruments lent by the Royal Microscopical Society, ranging from the copy of the simple microscope of Leeuwenhoek (1675) to the 1848 pattern of Powell and Lealand. A full account of them may be found in Dr. Dallinger's editions of "Carpenter on the Microscope." Modern methods of mounting microscopical preparations are represented, also the processes for the preservation of anatomical structures on the larger scale.

*Anthropology.*—Anthropometric contrivances are numerous, and gain some additional interest from recent regulations with regard to the medical inspection of schools and from the efforts being made to secure an anthropological survey of Britain.

*Geography and Geodesy.*—The Government has given but little assistance to the science section as a whole, but in this division we find much instructive material lent by the War Office and the Board of Agriculture and Fisheries, the former through the topographical section of the General Staff and the latter through the Ordnance Survey. The production of the topographical map of the Orange River Colony is illustrated in all its stages, and there is a fine collection of Ordnance Survey maps of the United Kingdom. The Royal Geographical Society contributes photo reproductions of original MS. maps by British explorers in Africa, including Livingstone, Burton, and Speke. Surveying instruments used in famous pre-Victorian expeditions are to be seen, and also those of the latest 1908 pattern.

*Geology and Geodesy.*—The Geological Society shows facsimile reproductions of early tables and maps by William Smith, 1799 to 1801. Photographs of British scenery illustrative of geological features are contributed by the Geological Survey and the British Association Committee, of which Prof. Watts is secretary. We direct attention to a new small geological map of the United Kingdom, scale 1 inch to 25 miles, published by the survey to provide teachers with a cheap and accurate map. In the palæontological division *systematic* research is illustrated by the grouping, viz.:—(*a*) collecting of fossils; (*b*) preparation of fossils; (*c*) study of fossils; (*d*) literary aids to research; (*e*) presentation of results.

*Oceanography.*—The Admiralty has lent the gear used by H.M.S. *Challenger*, 1872–6, photographic reproductions of Captain's Cook's original charts, and various pieces of apparatus used in sounding, both antique and recent. Biological specimens brought by the *Scotia* from the Antarctic can be seen, while the submarine cable companies contribute an attractive exhibit.

*Meteorology.*—No fewer than twenty-five pages of the catalogue are required for the enumeration of the items in this remarkably complete division. Here one may study the equipments of stations of the first, second, and third orders, and the methods of dealing with observations and results. Applications of meteorological statistics to agriculture and public health are instructively set forth. Apparatus for investigating the upper air, for observations on board ship, and for such special purposes as dust-counting, are on view. The historical collection includes Merle's weather journal, kept from 1337–44, and the earliest treatise on the barometer, published in 1688. Photographs of lightning flashes and of cloud-forms are numerous and of high quality. In the subdivision devoted to terrestrial magnetism will be found the results of the *Discovery* Antarctic Expedition.

*Astronomy.*—Though placed last in the official classification, this section is second to none in extent and interest. The observatories of Greenwich, Cape of Good Hope, Edinburgh, Cambridge, Oxford, Stonyhurst, and the Solar Physics Observatory of South Kensington have all contributed to a wonderful display of instruments and photographs. The subcommittee has arranged a stand to show the more important instruments required to equip a modern astrophysical laboratory. The large variety of objects of historical interest include an equatorial by Abraham Sharp (*circa* 1674), an astrolabe constructed for Sir Francis Drake, a Newtonian telescope made by W. Herschel, an Arabian astrolabe dated 1224 A.D., and autograph letters of John Flamsteed relating to Greenwich Observatory in 1712. In an adjoining case we found a photograph of the new satellite of Jupiter, discovered by Mr. Melotte on February 28, 1908. We cannot imagine a better way to view the progress of astronomy during the last two centuries than by visiting this exhibition.

*The National Physical Laboratory* sends photographs and duplicates of apparatus used in standardising and research. Regarding such an exhibit as a gauge of the degree of advancement attained in the branches of knowledge for which the instruments are employed, and of the degree of skill reached by our manufacturing firms, we may feel legitimate pride in recent advances, particularly in electrotechnics.

In dealing with a new enterprise, it is, of course, easy to find details which are susceptible of improvement, but in this case the only faults we observed were minor ones, and will mostly disappear under the capable directors who have brought so large an undertaking to such a high pitch of attainment with commendable punctuality. We cheerfully omit minor criticisms, and express our strong feeling of indebtedness to the workers who have done so well. We also thank the executive of the exhibition for endowing the Science Section to the extent of about 7000*l.* The best return for this labour and generosity will be an attendance of visitors such as the merits of the exhibition deserve.

G. F. DANIELL.

## CONFERENCE OF TEACHERS IN TECHNICAL INSTITUTIONS.

THE second annual conference of the Association of Teachers in Technical Institutions was held in London last week. The following are among the matters of wide interest discussed at the conference:—

(1) The necessity for the provision of two types of schools for the continuance of the education of boys and girls from the ages of fourteen to seventeen years. The first of these types corresponds with the present existing first-class "secondary" school, the second with the "trade" or "preparatory trade" school, which should be a secondary school with a marked "technical" bias. This school should prepare definitely for the trades, crafts, or industries.

(2) As a small but distinct educational advance, the minimum age of exemption from obligatory school attendance should be fourteen years, without any exceptions, as provided in clause 2 of the Education (Continuation Schools) Bill promoted by Mr. Chiozza Money. This, however, is only one step forward. The leaving age for trades, industries, or crafts, where the conditions of the trade permit, should be sixteen or seventeen years. From fourteen to sixteen years, the boy or girl should attend a school provided in accordance with paragraph (1) above.

(3) The technical institution has to deal with students who have received their preliminary training in the primary and secondary schools, often in the primary schools only. The average quality of the material from the primary and secondary schools is far from satisfactory. There is too often a certain lack of intellectual "grip" and thoroughness. How far this is due to the widening of the school curricula in recent years it is impossible to say. Signs are not wanting that in many schools the old evils of stringent individual examinations are being replaced by an evil almost as great, namely, the cramming of a number of pupils for the valuable borough and county scholarships now offered in such profusion. Technical colleges and schools have still to devote much valuable time, space, and equipment to work which should have been done in the secondary schools.

(4) In the case of a large number of students attending evening classes in technical schools, their sole previous educational training has been in the primary school up to the age of thirteen or fourteen years. About sixteen or seventeen years of age, or later, they enter the technical schools, after a period of three or four years during which

they have failed to receive any systematic education. The remedy for this blank period lies in the continuation school. At present, however, the continuation schools, except in a few isolated cases like Manchester, Leeds, Bradford, and Birmingham, fail almost completely in this aspect of their work. This is particularly the case in London, where one of the many pressing questions is the improvement of the evening continuation schools and the correlation of the schools to the polytechnics.

(5) Technical institution teachers are, naturally, keenly interested in the Imperial College of Technology. They look forward to sending their best students (day and evening), by means of scholarships or bursaries, to this institution for the highest *technical* training and research. Judging by the present rate of progress, this will be impossible for a number of years. There is danger that, instead of the college being a "college of technology," it will merely be an organised group of institutions doing practically the same kind of work as that which is done in an ordinary university college. The governing body of the college needs to be brought more closely into touch with the main current of English technical education than it is, apparently, at present, in order that the work of the college may be properly coordinated with that of existing technical institutions. The "preliminary" work now being done in the college, which is done also by a considerable number of institutions all over the country, should cease at the earliest possible opportunity, and the whole energies of the college concentrated on the highest possible technical training and research. We need an institution which shall bear the same proportion to the Manchester Municipal School of Technology as the latter does to the technical institute of a small provincial town.

(6) There is a pressing need for the establishment of a common matriculation or school leaving examination for admission to all British universities, the professions, and the (day) technical colleges, in place of the multiplicity of examinations and examining bodies existing at present. Coupled with this is the need for a revision in the syllabus of some of the chief matriculation examinations as at present conducted.

(7) Reference was made during the conference to the scheme recently put forward by the King's College (London) authorities for instruction in "household economics," based upon a thorough introductory course of chemistry, physics, elementary bacteriology, physiology, &c. While this would be undoubtedly beneficial in many ways, for example, in raising the status of "domestic science" teaching, it is felt by many technical institution teachers engaged in similar teaching in polytechnics and technical schools that the promoters of the King's College scheme have hardly done justice, in their preliminary publications and notices in the Press, to those engaged in such work in technical institutions. The impression given in these publications is that, up to the present, domestic science teaching has been empirical, "rule of thumb," and not based upon a knowledge of scientific "first principles." This is scarcely correct. For the last fifteen years the training schools of domestic economy attached to the polytechnics and technical institutions have increasingly, year by year, laid stress upon attendance at compulsory courses of chemistry, elementary physics, theory of education, and in some cases elementary bacteriology.

J. WILSON.

## SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES.

THE thirteenth annual congress of the South-Eastern Union of Scientific Societies was held at Hastings on June 10–13.

Sir Archibald Geikie, K.C.B., F.R.S., who followed Prof. Silvanus P. Thompson, F.R.S., in the presidential chair, took as the subject of his address "The Weald." He chose the subject because research in the problems connected with the Wealden area was eminently suitable for that combined action which local societies and field clubs are well fitted to provide. He spoke against the natural predisposition of the mind, in re-constructing the geography of former geological periods, to be too much influenced by the present grouping of sea and land. He sketched the part played by Godwin-Austen in the discovery of coal at Dover in consequence of his brilliant generalisation, after his profound study of the geology of N. France, Belgium, and S.-E. England (work which recalls, too, the names of Prestwich, Etheridge, and Boyd Dawkins). Having sketched the problem of the Palæozoic rocks, and having passed on to the deposition of the Purbeck and Wealden strata, he said that it was not easy to find the place whence the remnants of the terrestrial life of the Wealden deposits were derived, but indicated his belief that the crystalline and Palæozoic rocks of Brittany seem to be the greatly denuded core of an ancient land; for the Wealden deposits thin out rapidly in northerly, easterly, and westerly directions, and the only quarter which seems to offer itself as possibly that in which some vestige of the Wealden land may still remain lies to the south. Since the resources of modern petrography have armed the geologist of to-day with far ampler and more effective means of conducting the inquiry than his predecessors possessed, it would be well for some member of the union to undertake research into the origin of the pebbles found in the Ashdown Sand, the Wadhurst Clay, the Tunbridge Wells Sand, and occasionally in the Weald Clay.

The president sketched the various divisions of the Cretaceous rocks above the Weald Clay, emphasised the break between the Secondary and Tertiary periods, and then proceeded to discuss the evidences of the Ice age afforded by the Wealden area. Prestwich was disposed to think that the uplands of the Weald may have been a separate source of snow and ice, but he (Sir Archibald Geikie) did not think the evidence on which Prestwich relied was, perhaps, strong enough to warrant that conclusion. The decaying nature of the various rocks made observation of glaciation of the Wealden area difficult. But Prestwich may be right, and there may be other indications yet discoverable of "the traces of the Ice age in the Weald."[1]

The president also directed attention to the problem of the Coombe rock, and Mr. Clement Reid's ingenious solution of its origin, but thought that more directly convincing proofs of the Ice age were to be found in the transported boulders—granite, syenite, and mica-schist—found in such numbers along the south coast from Worthing to Portsea, brought thither on floating ice, perhaps from the region of crystalline rocks in the N.W. of France. Before the Arctic conditions finally passed away, there appear to have been some alternations of milder seasons, and the time was further marked by oscillations in the relative levels of land and sea, indicated, on the one hand, by lines of raised beach, and, on the other, by submerged forests.

Mr. E. A. Martin read a paper on some considerations concerning dew-ponds, a subject on which he has been engaged some time, encouraged by a grant from the Royal Society. Mr. W. J. Lewis Abbott read a valuable paper on Pleistocene vertebrates of the S.E. of England, and conducted an excursion to all the salient geological features of the district, which, after eleven years' observation, he is well qualified to do. He considers the Hastings uplift the most important, and his paper will modify previous views on this important area. Mr. Edward Connold contributed a paper on local sponges, which was a valuable contribution to this somewhat neglected branch of inquiry, and the same remark refers to Butterfield and Bennett's paper on the spider fauna of the Hastings district. Mr. W. H. Mullens discoursed on Gilbert White's connection with Sussex, and Mr. John Ray on mediæval timbered houses of Sussex and Kent. Mr. Wilfred Mark Webb touched upon a lighter theme in Darwinism as applied to dress, tracing the origin of some peculiar survivals in male and female attire.

Next year the meeting place will be Winchester, at the invitation of the Mayor and Corporation, and the president is to be Dr. Dukinfield Scott, F.R.S., president of the Linnean Society.

R. A. B.

[1] Mr. Lewis Abbott supplied some in his paper on "Pleistocene Mammalia of S.E. England," subsequently read to the Congress.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The general board of studies will shortly proceed to make the following appointments:—(1) A reader in zoology, in succession to Mr. Bateson; stipend, 100*l*. a year. (2) A reader in metallurgy; the stipend is the net income arising from the benefaction of 10,000*l*. given for this purpose by the Goldsmiths' Company. (3) A lecturer in economics, in succession to Prof. Pigou; stipend, 100*l*. a year. (4) A lecturer in historical and economic geography; stipend, 150*l*. a year. (5) A Royal Geographical Society lecturer in regional and physical geography; stipend, 150*l*. a year. (6) A Royal Geographical Society lecturer in surveying and cartography; stipend, 50*l*. a year. Candidates are requested to send their applications to the Vice-Chancellor, with testimonials if they think fit, on or before July 28.

The electors to the Frank Smart studentship in botany give notice that they will shortly proceed to the election of a student. Any graduate of the University is eligible for the studentship provided that not more than fourteen complete terms have elapsed after his first term of residence. The successful candidate must devote himself to research in botany. The studentship is ordinarily tenable for two years. The value of the studentship is 100*l*. per annum, or such larger or smaller annual sum as the fund may produce. A candidate must send his name, with a statement of the course of research which he proposes to undertake, and such evidence of his qualifications as he thinks fit, to the Vice-Chancellor, Gonville and Caius College Lodge, on or before Tuesday, June 23.

The general board of studies has appointed Dr. Anderson university lecturer in physiology, Mr. F. H. A. Marshall university lecturer in agricultural physiology, Mr. C. G. Lamb university lecturer in electrical engineering, and Mr. C. E. Inglis university lecturer in mechanical engineering, all for five years.

The first examination for the diploma in mining engineering will be held in the Michaelmas term. The examiners nominated are Mr. E. H. Liveing, formerly professor of mining in the Yorkshire College, Leeds; Prof. H. Louis, Armstrong College of the University of Durham; and Mr. C. T. Heycock, of King's College.

Mr. R. C. Maclaurin, St. John's College, has been approved by the general board of studies for the degree of Doctor in Science.

LONDON.—The assembly of the faculties of University College has been fixed for Thursday, July 2, at 3 o'clock, when Prof. A. F. Pollard will read a report on the work of the session, and the results of the University, scholarship and class examinations will be announced. Scholars and medallists will be presented to Sir Edward Fry, F.R.S., who will deliver an address.

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MR. A. D. HALL, director of the Rothamsted Experimental Station, will deliver a course of lectures on July 13–18 at the Graduate School of Agriculture, which the United States Department of Agriculture is holding this year at Cornell University. Mr. Hall will also deliver two lectures at the University of Illinois, Urbana, on July 7 and 8.

IN an address at the University of Wisconsin, Madison, on Sunday, Mr. Bryce is reported by the *Times* to have dwelt upon the useful relation which the State universities of western America bear to the States, commenting on the immense service rendered to scientific agriculture by the University of Wisconsin in increasing the product of the soil and the quality of the live-stock, making the farmer's life more interesting, and checking the influx of the people to the cities. It is wise, he remarked, not to allow practical subjects to oust theoretical physical science and human subjects. Theoretical science is the source and strength of progress in all industries and practical arts.

ONE of the departments of the Hungarian Exhibition at Earl's Court illustrates the progress and present position of education in Hungary. Starting with a section devoted to kindergartens and elementary schools, all the grades of education up to the universities, and colleges of university standing, are explained by suitable exhibits. A sketch of this part of the exhibition, which appeared in the *Times* of June 12, says that in every one of the grades photographs are on view illustrating the pupils and students at work in their classes. A very interesting feature is the model State farming school, in which all branches of farm work are taught to pupils between the ages of twelve and fifteen. Nursery-gardening instruction forms part of the curriculum at these schools also, and attention is paid to home and industrial work. The age at which education in Hungary is compulsory is in the kindergarten from three to six, and in the ordinary elementary school from six to twelve, while evening classes are given to pupils between the ages of twelve and fifteen. A *minimum* collection of implements used in all elementary schools is on view, embracing a wide selection of objects from chemical, mechanical, and electrical appliances to natural history specimens. The training college section contains excellent specimens of woodwork, and equally fine articles of lace and embroidery. Another feature is the attention paid to hygiene. So keen are the State authorities on securing a high standard of physical culture that every boy when he enters has his height measured and his strength tested. These details are entered in a register, which is kept as a record of his physical growth during his school years.

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## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, March 19.—"Secondary $\beta$ Rays." By Prof. J. A. **McClelland**. Communicated by Prof. J. Joly, F.R.S.

This paper deals with the secondary radiation of $\beta$ particles from a plate exposed to the $\beta$ rays from radium. It contains, in the first place, a detailed investigation of the intensity of this secondary radiation in different directions in the plane of incidence of the primary rays, and for different values of the angle of incidence.

The results show that the secondary $\beta$ particles may be divided into two parts. One portion of the radiation has a maximum value in the direction of ordinary reflection, and is referred to as the "reflected" rays. The reflected rays differ very little in intensity for different substances.

The author in previous papers has compared the intensity of the secondary $\beta$ rays from a large number of substances, and showed that it depends on the atomic weight of the substance. The secondary radiation increases with the atomic weight, and in such a way that the elements fall into divisions corresponding to the chemical periods. When the secondary radiation is analysed, as in the present paper, and the observations so taken as to exclude or reduce to a minimum the portion referred to above as the reflected rays, the connection with the atomic weight is brought out even more clearly than before.

The reflected rays are a more important fraction of the whole in the case of elements of low atomic weight, as for these substances the other portion of the radiation—the true secondary—is small.

The reflected rays are more marked when the angle of incidence is large.

Further evidence that there is a decided difference between the reflected rays and the other portion of the secondary rays, is given by measurements of the absorption in a direction in which the reflected rays are a maximum and in a direction where they are absent or a minimum. The reflected rays are similar in velocity to the primary rays, and vary little with the substance emitting them; the velocity of the true secondary rays is less than that of the primary rays, and depends on the substance emitting them.

The origin of the two parts of the secondary radiation is discussed in the paper, and the view taken that the reflected rays are some of the primary particles which in their path in the exposed plate have not entered into or caused change of energy in any atomic systems, thus retaining their original velocity and obeying approximately the law of reflection. The true secondary rays, on the other hand, are looked upon as $\beta$ particles expelled from the atoms of the exposed substance by the entry of the primary particles.

The paper further contains the results of measurements with a hemispherical ionisation vessel which give the sum of the secondary radiations in all directions from the exposed plate for different angles of incidence of the primary rays. A comparison of these results with those referring to the plane of incidence only, shows that the reflected rays are not strictly confined to the plane of incidence. Further work on this subject is in progress.

May 7.—"Helium and Radio-activity in Rare and Common Minerals." By the Hon. R. J. **Strutt**, F.R.S.

(1) Helium can be detected in almost all the minerals of the earth's crust.

(2) The quantity is in most cases about what might be anticipated from the traces of uranium and radium which the minerals contain. This is illustrated by the following selected results, which are given in round numbers only:—

| Mineral | Helium present, c. mm. per kilo. | Helium ratio, *i.e.* ratio of helium to uranium oxide |
|---|---|---|
| Samarskite | 1,500,000 | 14 |
| Hæmatite | 700 | 9 |
| Galena | 2 | 17 |
| Quartz | 2 | 10 |

(3) Where much higher helium ratios than the above have been observed, the excess of helium can always be connected with the presence of thorium, except in one outstanding case. Thus the experiments afford no evidence in favour of helium production by radio-activity of ordinary elements.

(4) The outstanding case is beryl, which contains abundance of helium, without anything approaching a sufficient radio-activity to explain its presence. This helium cannot be connected with any known constituent of beryl.

(5) Igneous rocks, and probably siliceous minerals generally, contain small quantities of argon. In other minerals its quantity is negligible, at all events in comparison with the helium present. Nor is there any indication that it increases with the amount of radio-active material.

May 21.—"A Further Note on the Nutrition of the Early Embryo: with Special Reference to the Chick." By E. **Emrys-Roberts**. Communicated by Prof. C. S. Sherrington, F.R.S.

(1) The secretion of the resting mammalian uterus contains protein, mucin, and salts; during the pro-œstral stage the proportion of mucin is decreased.

(2) The profuse mucinous secretion of mammalia during pro-œstrus is derived, not from the body of the uterus, but from the cervix and vagina.

(3) The nutrition of the embryonic chick is not dependent upon the yolk alone, but also upon the egg-white.

(4) Assimilation of the egg-white is divisible into three heads—the water, the salts, and the proteid.

(5) Of the three, the water is at first extracted at the most rapid rate, *i.e.* the percentage of water decreases as incubation proceeds.

(6) The percentage of salts in the egg-white remains more or less unchanged throughout incubation.

(7) The proteid of the egg-white is assimilated, not by a process of osmosis, but by a process of digestion performed by the chorionic cells.

(8) During this process the egg-white is considerably altered in composition and reaction, being converted, as incubation proceeds, into a more and more vitreous mass with a peculiar set of reactions, the outstanding reaction being that demonstrating the presence of albumoses and peptones.

**Physical Society**, May 22.—Dr. C. Chree, F.R.S., president, in the chair.—The spectrum top: F. P. **Sexton**. The coloured bands seen when a Benham top is rotated are explained. The effect depends upon the position of the sector lines and on a contrast. The rates of growth of the colour sensations are assumed to be in the order red, green, and blue, where red is the greatest, and the rates of decay are assumed to be in the inverse order. The colour in the inner ring with an anti-clockwise rotation, and also the second ring, are explained.—The coefficient of diffusion: B. W. **Clack**. The practicability of a new method for the determination of the coefficient of diffusion of salts through water, and to find how this coefficient varies with the concentration of the solutions, is discussed. The apparatus consists of a special kind of flask of about 450 c.c. capacity fitted with a vertical glass tube of known dimensions. The flask, filled with the salt solution, was suspended in cooled distilled water. The apparatus was so designed that one end of the vertical tube was maintained in contact with a salt solution of constant concentration, while the other end was kept in contact with distilled water. As the salt diffuses through the tube the weight of the flask varies, and an expression was deduced by which it is possible to find the value of the coefficient of diffusion from this rate of change in weight, which was automatically recorded. The salts experimented upon were NaCl, KCl, and $KNO_3$. The coefficient for NaCl and KCl decreases as the concentration of the solution decreases. For $KNO_3$ the opposite phenomenon is exhibited.—The production of small variable frequency alternating currents suitable for telephonic and other measurements: B. S. **Cohen**. A new method for producing these currents is described; this consists of a form of vibrating wire interrupter which operates a make-and-break contact. This is used to put a source of potential on and off a resonating circuit tuned to any desired frequency. The alternating current is taken from a small transformer in the resonating circuit. A series of damped wave-trains of any frequency can be produced by this means, the trains following each other with the frequency of the wire vibrations. The theory of action of the various circuits, and some applications of the waves to both telephonic and general electrical measurements, are given.

**Mathematical Society**, June 11.—Prof. W. Burnside, president, in the chair.—Relations between the divisors of the first *n* natural numbers: Dr. J. W. L. **Glaisher**.—Electrical resonance: Prof. H. M. **Macdonald**.—A form of the eliminant of two binary quantics: A. L. **Dixon**.—Perpetuant syzygies of the *n*th kind: H. **Piaggio**.

**Royal Astronomical Society**, June 12.—Mr. H. F. Newall, F.R.S., president, in the chair.—An example of Prof. Karl Pearson's calculation of correlation in the case of the periodic inequalities of long-period variables: H. H. **Turner**. After tabulating Chandler's periodic inequalities, the author worked out the correlation according to Prof. Pearson's method, and then made an examination of eight stars in detail for which special information was available.—Report of the expedition to Flint Island for the observation of the total solar eclipse of 1908 January 3: F. K. **McClean**. The author gave an account of his expedition, to undertake which he chartered a steamer to start from Auckland for Tahiti and Flint Island, being joined by a small party of astronomers from Australia and New Zealand. The difficulties of landing were overcome, and all preparations made, in spite of almost continual rains. Heavy rain came on upon the morning of the eclipse, and only ceased just as totality commenced. Very successful photographs of the corona and prominences were taken, which were shown to the meeting. Mr. McClean recommended the observation of the eclipse of 1910 in Tasmania, and Mr. Crommelin remarked that Halley's comet would come to perihelion about the time of the eclipse, and could be much better observed in the southern than in the northern hemisphere.—Observations of the sixth, seventh, and eighth satellites of Jupiter from photographs taken at the Royal Observatory, Greenwich: **Astronomer Royal**.—The orbit of Jupiter's eighth satellite: P. H. **Cowell** and A. C. D. **Crommelin**. Two hypotheses were considered, the one of direct and the other of retrograde motion; the question was not finally decided, but retrograde motion seemed much more probable. The orbit had 31° inclination from the ecliptic, and a period of about two years, but no definitive orbit could be obtained until the satellite had been again observed at the next opposition of the planet.—The mathematical theory of two star drifts, and on the systematic motions of zodiacal stars: A. S. **Eddington**.—The lunar bright rays: H. G. **Tomkins**. The author showed the different characteristics of the bright rays on the moon, and explained his theory that they are caused by salt efflorescence. Photographs were shown of saline regions in India and other countries, as well as specimens of saline deposits. He considered that there was evidence of a radial arrangement of terrestrial salt districts.

EDINBURGH.

**Royal Society,** May 4.—Prof. Crum Brown, vice-president, in the chair.—Sunset and twilight curves and related phenomena: D. M. Y. **Sommerville.** The objects of the paper were (1) to describe certain curves which approximate to the graphs of the time of sunset (or sunrise) and end of twilight (or daybreak) all the year round for various latitudes; (2) to tabulate the yearly phenomena of light and darkness for different latitudes under various conditions. The case of the earth was first discussed, and then the investigation was extended to cases in which the inclination to the ecliptic was given arbitrary values ranging from 0° to 90°, and in which also the same range was given to the limiting depression below the horizon of the sun's centre consistent with twilight conditions. The various possible combinations of daylight, twilight, and true night which make up any complete day were examined, and some interesting mathematical relationships obtained.—The electromotive force of iodine concentration cells in alcohol and water: Principal A. B. **Laurie.** The results show that if the E.M.F. is calculated from the mass equation constant determined by Jakowkin and the Nernst equation for osmotic pressure and E.M.F., the experimental results agree very closely where the potassium iodide is present in excess, but only approximately where the potassium iodide and iodine are present in sensibly the same proportions. In alcohol cells the E.M.F. results show a very close agreement with the Nernst equation for cells in which the potassium iodide is in excess, and also show that there is evidently a similar complex formed in the presence of alcohol as there is in the presence of water. The E.M.F. of cells in which mixtures of alcohol and water are used indicates that at 0° C. the dissociation of the potassium iodide is less for such mixtures than it is for alcohol or water, this effect disappearing at 25° C. Experiments with cells in which solutions of equal strength of iodine and potassium iodide were used, dissolved in water round the one electrode and dissolved in alcohol round the other electrode, show an E.M.F. of nearly two-tenths of a volt, the water solution being positive, and the action of the cell transferring iodine from water to alcohol and potassium iodide from alcohol to water. This alcohol-water cell has a considerable temperature coefficient, showing that heat is being absorbed during the passage of the current, but not so large as would be required by the Nernst equation if it was a purely gas-pressure cell. When connected to a galvanometer this cell gives a current for some hours.—Preliminary statement on the morphology of the cone of *Lycopodium cernuum* and its bearing on the affinities of Spencerites: Dr. W. H. **Lang.** The cone of *Lycopodium cernuum* is the most complex in the genus, but it was shown that in Spencerites certain of the most characteristic features were either distinctly visible or at any rate strongly suggested. Whatever view of their relationship be taken, there appeared to be a *prima facie* case for regarding the morphology of the cone as essentially the same in the two forms.—The origin of the adaxially curved leaf trace in the Filicales: D. T. Gwynne **Vaughan** and Dr. R. **Kidston.** As exhibited in *Thamnopteris Schlechtendali*, the leaf traces leave the stele in a thoroughly protostelic manner when free, at first appearing as an oval mass of xylem with a central protoxylem. While in this form an island of parenchyma appears adaxially to the protoxylem, which, gradually increasing, eventually displaces the centripetal xylem. By progressive stages the characteristic leaf trace becomes curved, and assumes the characteristic horse-shoe form so common to the Filicales.—A new species of Dineuron and of Botryopteris from Pettycur, Fife: Dr. R. **Kidston.**—The inca or inter-parietal bone, its homology and nomenclature: Dr. W. R. **Smith.**

May 18.—Prof. A. Gray, vice-president, in the chair.—The cohesion of steel, and on the relation between the yield points in tension and in compression: G. H. **Gulliver.** In a homogeneous isotropic solid the directions of maximum shearing stress are inclined at 45° to the directions of principal stress. Because of internal friction, the surfaces of sliding will be inclined to the direction of maximum tension at an angle which is greater than 45° by half the angle of friction. Experiments on steel bars lead to the value 0·176 for the coefficient of friction, a value which corresponds closely with the ordinary coefficient of friction for dry metallic surfaces. The shearing stress along a surface of sliding is always greater than the frictional resistance due to normal stress upon the same surface. Assuming this to be due to a cohesive force acting normally to the same surface, the author calculated the value of this cohesion for steel as being 3·384 times that which corresponds with the tension yield point, or 2·384 times that which corresponds with the pressure yield point. Experiment fully corroborated this conclusion. Experiments also confirmed the further conclusion that the fracture of a bar under tension begins in a direction normal to the axis.—The preparation of a glass to conduct electricity: C. E. S. **Phillips.** A mixture consisting of thirty-two parts of sodium silicate, eight parts of borax, and one part of Powell's glass is fused in a platinum crucible. The air bubbles are rapidly removed from the mass by means of a vacuum pump, and the resulting glass pressed into plates or cast in the usual way. The conductivity of this material is comparatively high, being about 1000 times greater at 20° C. than ordinary soda glass at 100° C. Its specific resistance is $5 \times 10^8$ ohms at 20° C. The index of refraction is 1·6, the density 2·6, and the softening point 551° C. On account of the high coefficient of expansion, viz. 0·00015, the conducting glass cannot be welded to ordinary tubing except by means of glasses with intermediate coefficients of expansion. The study of the surface changes was made by means of an electrical method depending upon the negative electrification of cadmium when in contact with a moist surface of the conducting glass. It was found in this way that the substance attracted less moisture with time, and therefore slowly improved. Some experiments were shown which proved that the glass conducts electricity through its mass, and that the effect is not merely a surface one.

PARIS.

**Academy of Sciences,** June 9.—M. H. Becquerel in the chair.—An apparatus designed for micrometric levellings: M. **Gouy.** A microscope furnished with a wire micrometer, and standing upon a tripod the feet of which are ivory points, slides on a plane horizontal disc of polished glass. The micrometer wire being first set on the object the position of which is to be measured, its position on the standard scale is found by sliding the tripod over the disc until the divisions of the scale are in focus. As showing the accuracy obtainable by this simple method, the probable error of a setting of the micrometer, the microscope remaining fixed, was found to be 0·043 $\mu$, whilst when the microscope was moved over the disc between each setting the probable error of a setting was 0·042 $\mu$.—The direct addition of hydrogen to the polyphenols: Paul **Sabatier** and A. **Mailhe.** Previous attempts to apply the Sabatier and Senderens reaction to the diphenols and triphenols have failed, due, as is now found, to the employment of too high a temperature in the reaction. At a temperature of about 130° C., in a rapid current of hydrogen, hydroquinol, pyrocatechol, resorcinol, and pyrogallol give good yields of the corresponding *cyclo*hexadiols and triols respectively. Hydroquinol gave the *cis*-quinite exclusively, and pyrocatechol and resorcinol also appeared to give the *cis*-compounds, although this point has not yet been completely proved. Since this method yields these compounds easily, and in a very pure state, a special study is being made of the properties of these derivatives.—Magnetic observations at Tananarive: E. E. **Colin.** Three tables are given showing the results of the absolute measures of declination, of inclination, and of the horizontal intensity, from May, 1907, to April, 1908.—The exact analysis of marsh gas. The dissociation of several hydrocarbons obtained in the grisoumeter and eudiometer: Nestor **Gréhant.**—The regulation of electrogenic groups: J. L. **Routin.**—The development in a continued fraction of an algebraical number: M. **Auric.**—The true cause of the doubling of the curve of loss of activity of conductors covered with a dielectric layer, rendered radio-active, and with an electric charge: Ed. **Sarasin** and Th. **Tommasina.**—The sign of electric dichroism and of magnetic dichroism: Georges **Meslin.**—The self-induction spark: André **Léauté.** The essential cause of the striæ observed for the first time in the photographs of M. Hemsalech is the existence of two circuits in parallel.—Catalytic dehydrations of organic compounds: J. B. **Senderens.** Several inorganic substances have been found by the author to possess catalytic properties, the most active being precipitated alumina dried at a temperature below a red heat. This substance at about 300° C. splits up ethyl ether into ethylene and water, acetic acid (at 350°) into acetone, water and carbon dioxide, propionic acid into diethylketone, water and carbon dioxide, ethyl acetate into water, ethylene, carbon dioxide and acetone, and ethyl oxalate into water, carbon monoxide and dioxide, and ethylene.—The action of silver nitrate upon chloroauric acid, and the preparation of fulminating gold: Jules **Jacobsen.** Pure chloroauric acid, prepared by the action of chlorine upon pure gold in suspension in hydrochloric acid, is precipitated by silver nitrate, the precipitate having the composition $Au(OH)_3.4AgCl$. A solution of ammonia removes the silver chloride from this substance, leaving a yellow, flocculent precipitate of fulminating gold. Analyses of this latter gave figures corresponding to the formula $Au(OH)_2NH_2$.—The separation of ammonia and the amines by means of boiling absolute alcohol: Jean **Bertheaume.** It is shown that this commonly used method of separation is imperfect, a determination of the solubilities of ammonium chloride and methylamine hydrochloride proving that at least 8·5 per cent. of ammonium chloride is always present in methylamine hydrochloride purified in this manner.—Contribution to the study of the artificial peroxydiastases: J. **Wolff.** A study of the oxidation of pyrogallol by hydrogen peroxide in presence of colloidal ferrocyanide of iron. The effects of the latter are shown to be in all respects comparable with those of the natural peroxydases.—A new mica of the paragonite group: Ph. **Barbier.** This mica is characterised by its proportions of soda (7·6 per cent.) and lithia (1·2 per cent. to 2·0 per cent.), the association of these two elements, sodium and lithium, being unusual. The name hallerite is proposed for the new mineral.—A certain function of hepatic replacement exercised by the feather in birds: Jean **de La Riboisière.** For any species of bird the amount of liver and feathers, referred to 100 grams of the total weight, may undergo extensive variations. But it would appear that in each species those individuals having more liver have less feathers, and reciprocally.—The *rôle* of the yeasts and the nature of the vine in the formation of bouquet in wine: A. **Rosenstiehl.**—The iron deposits of Coatquidan: F. **Kerforne.** This deposit was worked for iron ore in 1825, but after some time was abandoned. The ore is a red hæmatite, containing a considerable proportion of fine quartz grains. Its geological level is at the base of the Armorican grit.—The principles to be applied to render buildings aseismic: Montessus **de Ballore.** Armoured concrete is the best material for building purposes in countries liable to earthquakes.

## DIARY OF SOCIETIES.

*THURSDAY*, JUNE 18.

ROYAL SOCIETY, at 4.30.—(1) An Electrical Method of Counting the α Particles from Radio-active Matter; (2) The Charge and Nature of the α Particle: Prof. E. Rutherford, F.R.S., and Dr. Hans Geiger.—The Scattering of the α Rays by Matter: Dr. Hans Geiger.—Studies of the Processes Operative in Solutions. Part VI., Hydration, Hydrolation and Hydrolysis as Determinants of the Properties of Aqueous Solutions; VII., The Relative Efficiencies of Acids as deduced from their Conductivities and Hydrolytic Activities; VIII., The Influence of Salts on Hydrolysis and the Determination of Hydration Values; IX., The Determination of Optical Rotatory Power in Solutions; X., The Changes Effected by the Reciprocal Interference of Cane Sugar and other Substances (Salts and Non-electrolytes): Prof. H. E. Armstrong, F.R.S., and others.—The Electrolytic Properties of Dilute Solutions of Sulphuric Acid: W. C. D. Whetham, F.R.S., and H. H. Paine.—The Giant Nerve Cells and Fibres of *Halla parthenopeia*: Dr. J. H. Ashworth.—On Methods for the Continuous (Photographic) and Quasi-continuous Registration of the Diurnal Curve of the Temperature of the Animal Body: Prof. A. Gamgee, F.R.S.

CHEMICAL SOCIETY, at 8.30.—The Thermal Decomposition of Hydrocarbons, Part I., Methane, Ethane, Ethylene and Acetylene: W. A. Bone and H. F. Coward.—The Rusting of Iron: W. A. Tilden.—Studies on Elementary Zirconium: E. Wedekind and S. J. Lewis.—(1) The Constituents of Canadian Hemp, Part I, Apocynin; (2) A New Synthesis of Apocynin: H. Finnemore.—The Constitution of the Diazonium Perbromides: F. D. Chattaway.—Cholestenone: C. Dorée and J. A. Gardner.—A New Form of Potash Bulb: A. E. Hill.—Solubility of Silver Chloride in Mercuric Nitrate Solutions: B. H. Buttle and J. T. Hewitt.

LINNEAN SOCIETY, at 8.—Altitude and Distribution of Plants in Southern Mexico: Dr. Hans Gadow, F.R.S.—The Marine Algæ collected in the Indian Ocean by H.M.S. *Sealark*: A. Gepp.—Nudibranchs from the Red Sea, collected by Mr. C. Crossland: Sir Charles Eliot, K.C.M.G.—The Algæ of the Yan Yean Reservoir, Victoria: G. S. West.—Bryozoa from the Indian Ocean, chiefly from the Collections made by H.M.S. *Sealark*: A. W. Waters.—On *Gardenia Thunbergia*, Linn., and its Allies: Dr. Otto Stapf, F.R.S., and J. Hutchinson.—*Exhibits*: Portfolio of Coloured Drawings illustrating the Flora of Bombay Island: Mrs. Harry Gay.—Specimens of *Melitella pusilla*, Somm., belonging to a New Genus of Compositæ, recently discovered by Cavaliere S. Sommier, in the Island of Gozo, near Malta: J. F. Duthie.

*TUESDAY*, JUNE 23.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—The Kurdish Tribes of the Ottoman Empire: Mark Sykes.

FARADAY SOCIETY, at 7.45.—Annual General Meeting.—At 8.15.—Recent Developments of the Kjellin and Rochling-Rodenhauser Electric Induction Furnaces: J. Härden.—New Applications of Electrometallurgical Alloys: Adolphe Jouve.

*THURSDAY*, JUNE 25.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Have Trypanosomes an Ultra-microscopical Stage in their Life-history? Colonel D. Bruce, C.B., F.R.S., and Captain H. R. Bateman.—The Action of Chlorine upon Urea whereby a Dichloro Urea is Produced: Dr. F. D. Chattaway, F.R.S.—Further Note on a Luminous Glow generated by Electrostatic Induction in an Exhausted Vessel made of Silica: Rev. F. J. Jervis-Smith, F.R.S.—On the Reflection of Waves from a Stratum of Gradually Varying Properties, with Application to Sound: Dr. J. W. Nicholson.—The Electrical Forces of Mitosis and the Origin of Cancer: A. E. and A. C. Jessup, E. C. C. Baly, F. W. Goodbody, and E. Prideaux.—The ω-Function—a Class of Normal Functions: E. Cunningham.—And other papers.

*FRIDAY*, JUNE 26.

PHYSICAL SOCIETY (at the National Physical Laboratory, Bushy House, Teddington), at 3.30.—Demonstrations of Work in Progress in the Laboratory.

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THURSDAY, JUNE 25, 1908.

## METEOROLOGY OF INDIAN SEAS.

*Meteorological Atlas of the Indian Seas and the North Indian Ocean.* Prepared chiefly by W. L. Dallas, under the direction of Dr. Gilbert T. Walker. Pp. viii+36 charts. (Simla: Published by the Meteorological Department of the Government of India, 1908.) Price 17s. 6d. net.

ALTHOUGH steam has almost entirely superseded sail for the propelling of ships, there nevertheless appears to be a steadily increasing desire on the part of sailors for accurate information relating to marine meteorology, and recognition of its importance in the interests of navigation.

A meteorological atlas, recently published by the Meteorological Department of the Government of India, should therefore be welcomed by seamen who navigate the ocean areas of which it treats.

This atlas is composed of thirty-six charts, printed in colours, beautifully finished, and accompanied with descriptive remarks. Twelve of these are designed to show the average conditions of atmospheric pressure, wind, and sea-surface currents, or "sea currents," as they are termed in this volume. The value of the charts would have been enhanced if results of air-temperature observations had been added. The effect of a prevailing wind upon mean temperature, and the relation between temperature and pressure are problems of interest to students of meteorology.

Nine charts show the monthly tracks of important cyclones, and cyclonic storms, over the Arabian Sea and Bay of Bengal; and fifteen charts the conditions prevailing, and the changes taking place, during the existence of typical storms in those areas.

The charts refer to an area embraced by the parallels of 30° N. and 12° S. lat., and the meridians of 40° E. and 100° E. long. The monthly charts of barometric pressure, wind direction, and force exhibit mean results of 8 a.m. observations (local time) for areas of 4° of latitude and 4° of longitude.

Pressure is shown in red by isobars, but is also given in tenths and hundredths of an inch, in the left-hand upper corner of each 4° square. Wind direction is indicated by an arrow in black, and wind force (by Beaufort scale) by figures at the tail of each arrow, which denote the mean force for the whole of the 4° square to which the arrow refers. The flow of the currents is shown, in blue, by wavy arrows, and the velocity in nautical miles per 24 hours is given, in most cases by figures attached.

In the directions for using the pressure data a table is given for the purpose of reducing readings of the barometer, at any hour of the day, to that of 8 a.m. For the sailor this is a useful table.

A defect in this volume is the absence of any information with respect to the number of observations upon which the results for each meteorological element is based. Wind direction, for instance, may be based on 2, 200, or more observations; they may be all for one year, or may be spread over a number of years; they may be recorded by one ship, or by many ships.

The wind arrows shown on the first twelve charts are said to represent the mean direction of the wind, but the exact meaning of the term "mean direction" is not stated. It may be the prevailing direction that is meant, or it may be the resultant wind. In any case a single wind direction in each square, either for the purposes of scientific investigation or for the uses of the navigator, is inadequate for the representation of wind distribution, even where the wind's direction is most constant. Information relating to wind frequency, in order to be of value to the sailor, should deal with the percentage of frequency of all winds within definite areas; and for the Indian Ocean, Bay of Bengal, and Arabian Sea this is essential. In order to show the march of the south-west monsoon from east to west at its commencement, the gradual changes from north-east and north-west monsoons to south-west monsoon, and the reverse, and to exhibit clearly the northern limit of the south-east trade wind, month by month, nothing short of a complete wind rose will suffice.

The wind directions and forces have been, it is stated, extracted as they stood in the ships' log-books. This may be regarded as sufficiently accurate in connection with wind direction, as the magnetic variation over the area treated is small, and the deviation of ships' compasses is now usually kept within negligible limits; but as regards wind forces it is otherwise. The objections in this respect to the method adopted are, however, recognised, and are alluded to as follows:—

"They may represent the ordinary force of the wind, over the square to which they refer, or they may arise as the average of winds of widely varying velocities."

To meet this difficulty the sailor is referred to the remarks for the month, given in the pages opposite the charts; but it seems doubtful whether these remarks will help the sailor much in all cases, as only the most general information is given in this connection. Owing to the absence of information as to the number of observations on which each wind arrow is based, it is not possible to compare the direction and force of the wind in one square with those of another, or to estimate the chances of experiencing any wind other than the mean wind in any particular square.

The information relating to surface currents has been copied, it is stated, from the "Monthly Current Charts for the Indian Ocean," issued by the Hydrographic Department of the Admiralty. The charts dealing with the track of storms, and those illustrating typical storms in the Arabian Sea and Bay of Bengal, in different seasons of the year, should prove exceedingly valuable to the sailor, especially the former.

It is to be regretted that in this work the term "cyclone," used by most meteorologists to define a characteristic distribution of pressure and wind, has been employed instead to express the force of the wind in a tropical revolving storm. The term was originally adopted by Piddington in his "Sailors' Horn Book"

(1848), when, in reference to the classification of winds, he says:—

"I suggest that we might for this last class of circular, or highly curved winds, adopt the term 'cyclone,' from the Greek κυκλος (which signifies, amongst other things, the coil of a snake), as neither affirming the circle to be a true one, though the circuit may be complete, yet expressing sufficiently the *tendency* to circular motion in these meteors."

In the volume under notice the definitions given in this connection are as follow:—

"A cyclonic circulation in which the winds do not exceed force 10 is termed a 'cyclonic storm,' while a circulation in which the winds are of hurricane force, 11 to 12, is called a 'cyclone.'"

According to the Beaufort scale, storm force is expressed by the number 11; while employing this scale, is it not illogical to define a circulation, in which the winds do not exceed 10, as a "cyclonic storm"?

The copious remarks which accompany the charts are interesting and instructive, and add greatly to the worth of the volume. M. W. C. H.

## A TEXT-BOOK OF TROPICAL MEDICINE.

*Tropical Medicine, Hygiene, and Parasitology.* A Handbook for Practitioners and Students. By Gilbert E. Brooke. Pp. xvi+498. (London: Charles Griffin and Co., Ltd., 1908.) Price 12s. 6d. net.

THIS is a volume of the well-known medical pocket-book series, and corresponds in size and binding to Davies's "Handbook of Hygiene." It is a book of five hundred pages, and is divided into four sections.

The first section deals with the hygiene of the tropics, and discusses climate, food, exercise, clothing, hygiene of the mouth, pregnancy, and infant feeding in the tropics. The information and advice given in this section are useful and practical. For example, in regard to alcohol the author is of opinion that while it is not absolutely necessary for a man in any climate, a small quantity well diluted is often beneficial in the tropics. Most experienced travellers will agree with this, since the debility and consequent want of appetite brought about by tropical heat renders the stimulating effect of alcohol more necessary in warm than in temperate climates. Three ounces of whisky in the twenty-four hours is stated by the author to be the maximum which should be taken by a man in health. This will be thought by many dwellers in the tropics to be a counsel of perfection, but certainly the advice is sound, practical, and necessary. In regard to mosquito-bite prophylaxis, Dr. Brooke recommends various external applications; but surely experience teaches that these are of little or no practical use. The best protection is a good mosquito net. The author, speaking of mosquito nets, rightly says that the net in common use is a snare and a delusion. The best plan certainly is to have a permanent mosquito-proof room, which can, if necessary, be rigged up with ordinary mosquito-netting at the cost of a few shillings. In this room, or part of a room, there should only be a bed, a table, and a lamp. If one has to dine out where mosquitoes are numerous, a pair of Wellington boots may be found more productive of a calm, equable mind than the ordinary silk socks and pumps of fashion. Dr. Brooke seems to be of opinion that tropical medicine is something quite different from the medicine taught in the schools, and that no one can pretend to treat these diseases unless he has had special training. There seems to be too much made of this nowadays. Surely with a five years' curriculum it should be possible to teach a student the art of medicine sufficiently thoroughly to enable him to recognise a new disease when he comes in contact with it for the first time! A carpenter is not supposed to have made everything during his apprenticeship. He is taught the principles of his trade, and afterwards applies them to his daily work, whatever it may be.

The second section deals with medico-biology, and includes the classification of animal and vegetable parasites, notes on tapeworms, nematodes, mosquitoes, fleas, ticks, and snakes. Here also a great deal of useful information is compressed into some eighty pages; and there are several plates giving figures of the ova, larvae, and worms most commonly met with. Of course, as is unavoidable in the compilation of a text-book, more or less trivial errors are apt to creep in, such as the name *Streptococcus pyogenes aureus*, or the assertion that *S. scarlatinae* is the cause of scarlet fever, or that the tsetse-flies act as hosts in the spread of *Piroplasma bigeminum*, and such-like slips of the pen; but these do not really take away from the general usefulness of the section.

The third section is devoted to the description of the etiology, symptoms, and treatment of tropical diseases. These are arranged alphabetically, which arrangement has little to commend it, especially as the author has tried his hand at nomenclature and evolved two new names for sun-stroke, Phœbism and Diathermasia! On the whole, the descriptions of the various diseases are clearly given and well illustrated. In a rapidly progressing subject such as that of tropical diseases is at present, it is scarcely possible for a text-book to be quite up-to-date. In the description of dengue, for example, there is no notice of the recent important work which has been done in the etiology of this disease. In Malta fever it is stated that the method of transmission of the disease is uncertain. That is not so. This was clearly established two years ago, when it was shown that Malta fever is carried from infected goats to man through the medium of milk. Since goats' milk was banished from the dietary this fever has practically disappeared from the English garrison in Malta. This fact should be placed in the forefront of the description, and everything else made subsidiary to it. Again, what is the use at the present day of writing that Manson considers the weight of evidence to point to its diffusion by air-currents rather than by food and water? This is an old speculation which ought to be decently buried and forgotten. Further, more than half a page, in the account of the same fever, is devoted to describing some experiments carried out by two naval surgeons. These experiments ought not to have been made, for several reasons. These gentlemen had no right to risk their lives or health without sufficient reason while in the public service. It was unnecessary to carry out the experiments on man, as lower animals were available. Even if one or both had taken the disease, the experiments would have been useless, as they were living in the endemic zone and liable to take the disease naturally. What was the use, for example, of two non-immunes drinking urine from a case of Malta fever if they neglected in the first place to demonstrate that the urine contained the *Micrococcus melitensis?* As only one sample of urine in ten contains the cocci, it was ten to one against their taking the disease. Such thoughtless experiments ought not to be encouraged by being recorded in text-books as praiseworthy actions or serious attempts in the investigation of disease. With the exception of slight blemishes such as these, which, indeed, are inseparable from text-books, the descriptions of the various tropical diseases are good, and some are excellent. Especially is the description of the symptoms and treatment of these tropical maladies quite practical and useful.

The fourth section is taken up with practical hints in microscopy, photography, disinfection, examination of blood, &c. This part of the book contains much sound advice on the best microscopes and cameras for tropical work, on stains, staining methods, modes of preparing blood and tissues for examination, and should prove very useful to medical men in out-of-the-way places out of touch with books and laboratories.

The book concludes with several appendices on sanitary conventions, vegetable poisons of the tropics, how to collect flies, ticks, &c.

This text-book on tropical medicine can be confidently recommended to colonial surgeons and medical officers of the British and Indian Services as containing a vast amount of data from various sources, with practical hints from the author's personal experience and observation, which makes it an admirable *vade mecum* when the exigencies of travel render the carriage of several books impossible.

DAVID BRUCE.

## A MONOGRAPH OF BRISTLE-WORMS.

*A Monograph of the British Annelids.* Vol. ii., part 1. Polychæta, Nephthydidæ to Syllidæ. By Prof. W. C. McIntosh, F.R.S. Pp. viii+232+lxx plates. (London: Dulau and Co., 1908.) Price 25*s*. net.

WHEN Huxley was appointed professor in the Jermyn Street School of Mines, his first great scheme was the publication by Government of a zoological coast survey of Great Britain, and one of the first groups to be selected was this one of the Annelids. Unfortunately for biology that scheme was never carried out, and the opportunity that presented itself some fifty years ago of obtaining State assistance for what was truly a State work has not recurred. Not only has the publication of systematic coastal work been left to isolated ventures, but many groups, and the Annelids among them, have been so little studied on our own coasts that the work of naming any of the most common littoral species (except perhaps the lugworm) is out of all proportion to the value of its determination. Yet these Annelids are not only of great interest to the zoologist, but, as forming one of the chief foods for fish, they are among the most important factors in the welfare of our fisheries. The Ray Society and the Carnegie Trust are therefore to be congratulated on the issue of another section of this great monograph, which they have subsidised. Prof. McIntosh is known and read of all students of biology, and his unwearied devotion to this work, his wide knowledge, and long experience of these Annelids constitute him a master. He, perhaps of all men, was the only one who could write this work, and the completion of his monograph begun so many years ago is indeed a consummation devoutly to be wished. May he have the health and assistance necessary to that end.

The present instalment contains a systematic account of six families. Its most striking feature lies in the coloured plates drawn by the author's sister, the late Mrs. Günther, and the artist Miss A. H. Walker. These presentations of Phyllodocids, Hesionids, Nephthyds, and Syllids are most beautiful, and suggest many problems of coloration and of movement that are not referred to in the text. The fine green colour of many Phyllodocids tingeing even their egg-masses, the prevalence of segmental spots in most families, and the significance of varietal colorations, are subjects on which we possess very little organised knowledge, for if the systematic study of Polychæt Annelids has been neglected in this country, the bionomics and physiology of the groups have been left to a few Continental observers. It is to be hoped that the issue of this work will stimulate the study of the group in these directions.

There are two serious drawbacks to the value of this work which a little trouble could easily have obviated. If one wishes to find out what families, genera, and species are described in this part, there is no means of doing so except by wading through the text. A table of contents is not much to ask for, but it has been omitted, and as there is no index the labour of finding out what there is in the work is quite needlessly enhanced. The headings of the left-hand pages might well have given the family name under consideration instead of the species as at present. The second drawback is the binding of six extraneous plates right in amongst those proper to the part, sandwiched in between those illustrating two other families. These intrusive plates evidently belong to a later section of the work; yet we find no reference to their presence, and the confusion that is likely to arise ought to induce the council of the Ray Society to take some steps in order to avoid the repetition of, and if possible rectify, what we presume must be an oversight.

To turn from matters of editorial criticism, we are glad to see that Mr. Goodrich has given his skilled assistance and expert knowledge of the nephridia of these animals, so that these organs are adequately referred to and figured in the text. The references to other recent work on this subject show that not only the merely diagnostic literature, but all that bears upon the subject, has been exhaustively studied.

Among the most interesting sections is the one bearing on the Syllids. It has long been known that these Annelids are capable of asexual reproduction, and that the buds so formed, on assuming maturity, carry their eggs attached to their feet. Prof. McIntosh refers to several interesting cases of bud-formation. Certain American species of Trypanosyllids, for example, give rise to lateral buds, the stock assuming a frond-like appearance. Mr. Crossland has found an East African Syllid which has a crown of buds at its hinder end, and other species which are parasitic on Nemertines, Polychæts, and other hosts. There are some thirty representatives of this family already known from British waters, and their description and changes of form on assuming maturity are fully dealt with.

The distribution of these Polychæt Annelids will undoubtedly form a most interesting mass of evidence when it is collated. In its present form no conclusions can be safely drawn. We can only say that many species have a very wide range, extending to both sides of the Atlantic, and occurring as far north as Greenland and as far south as the Falkland Islands, whilst in some cases the same species is found both in the Atlantic and in the Indian Oceans. It is also clear that the British Polychæt fauna is probably as rich in specific variety as that of any other coasts so far explored. The coasts of Ireland, though not so thoroughly worked as those of the Channel or of the east of Scotland, have yielded many interesting forms, and the careful comparison which the author has instituted between specimens from different localities and between those of our own and of other coasts is but one instance of the careful discrimination and comparison which distinguish the work. We are glad to see that another part is ready for press, and we hope that financial aid will be forthcoming to complete this monograph.

## DIRECT-CURRENT ELECTRICAL ENGINEERING.

*Principles of Direct-current Electrical Engineering.* By J. R. Barr. Pp. viii+454. (London: Whittaker and Co., 1908.) Price 10s. net.

As the author states in the preface, this treatise was primarily written for the use of intermediate classes in universities and technical colleges, and is based on his lectures to second-year students. It is intended to bridge the gap between the several elementary manuals and the many works on special branches, and in this object the author has succeeded admirably. During the last few years innumerable books dealing with direct-current electrical engineering have appeared, but they are either too elementary or else too highly specialised. This book deals chiefly with principles, but the author has kept not only the theoretical, but also the practical side of the question well in view.

The first two chapters are devoted to the units employed in electrical engineering and the fundamental principles, such as Ohm's law, the heating effect of currents, &c., while the third chapter deals with electromagnetism and the magnetisation of iron. The latter chapter gives the student a clear insight into the magnetic quantities underlying the design of dynamos and motors. A short description is given of Ewing's hysteresis tester and permeability bridge, and the method of using it.

About sixty pages are occupied with a discussion of electrical measuring instruments. The principles governing the construction of ammeters, voltmeters, wattmeters, and electric-supply meters are set out in a clear and practical manner, and even maximum-demand indicators are briefly touched upon.

Two chapters treat of storage batteries and electric lighting, but these are rather disappointing. Surely the short section dealing with metallic filament lamps might have been amplified with some advantage, especially considering the enormous progress made in illuminating engineering. It is, further, somewhat out of date to take up a section with a discussion of 37-volt osmium lamps. Practically speaking, these lamps are not used at all, and in all probability their manufacture has been abandoned for some time. It would have been better to have given us particulars about the osram, wolfram, tungsten, and zircon-wolfram lamps, which are now made for 250-volt circuits, and are of great practical importance. Open, enclosed, and flame-arc lamps are briefly touched upon, as well as illumination and photometry, but on the whole this chapter is, as already said, rather unsatisfactory.

Overhead and underground conductors, and the principal methods of laying cables, as well as the calculation of voltage drop in conductors, are next described in about forty pages.

The last six chapters of the book are devoted to dynamo-electric machinery, its construction, design, and operation, and these chapters are undoubtedly the best in the book. The construction of armatures, commutators, and brushes is very fully dealt with, and the use of coloured diagrams used for illustrating the various methods of armature windings should be extremely useful to students. The theory of the magnetic circuit is gone into very carefully, and it will give the student a clear insight into the calculations required for the design of dynamo-electric machinery.

The methods of determining characteristic curves, parallel operation, and methods of voltage control are also considered, while one chapter deals with motors and controllers. The section on testing is very brief, and it is hoped that in a next edition this may be somewhat enlarged.

In the last chapter we come to the subject of electricity control, and the author enters fully into the points connected with switchboards. The section dealing with fuses, circuit-breakers, lightning arresters, and switches is excellent, and contains a large amount of practical information. Various examples of switchboard designs, illustrated by working drawings, complete a very interesting chapter. At the end of the book there is an appendix containing practical problems to be worked by the students.

The author is to be congratulated upon the work which he has produced. It is not too practical or too theoretical, but contains just the information which a second-year student wants. The book is well printed, and contains a great many working drawings and diagrams. It is hoped that the author may find time some day to write a companion volume on alternating-current electrical engineering.

L. C.

## EDUCATION AND EMPLOYMENT.

*A Handbook of Employments.* Specially Prepared for the Use of Boys and Girls on Entering the Trades, Industries, and Professions. By Mrs. Ogilvie Gordon. Pp. 444. (Aberdeen: Rosemount Press, 1908.) Price 1s. net.

THE system of apprenticeship, which has been so largely instrumental in producing and maintaining the highly skilled workmen for which English industry has always been famed, is slowly but surely dying out. Especially in the large towns, it is more and more difficult to find employers who are willing to take bound apprentices; they complain that such apprentices take little interest in their work, are not so willing or anxious to please as boy labourers, and that the high rents they have to pay in towns make their bench room so expensive that in these days of keen competition they cannot afford to take apprentices.

On the other hand, there are so many ways in which boys from fourteen to eighteen can earn comparatively high wages in unskilled employments, that the temptation to their parents to abandon any attempt to apprentice them and to make them immediate wage-earners is very strong.

To endeavour to counteract these tendencies, several local authorities have started some form of industrial or trade school, and although these will never probably take the place of apprenticeship, as the conditions in a school can never be the same as in the shops, they will help to stimulate the interest of the boys in manual pursuits, and so form a strong incentive to learn some trade; and they will also make the trade easier to acquire by the training of eye and hand they have received in the school, as well as by the knowledge they have acquired.

These schools may therefore be expected further to increase and develop, and may become gradually a necessity of our industrial system. But whereas the old apprenticeship system automatically regulated the supply to the demand, any artificial system of drafting boys into given trades will need careful control.

The introduction to Mrs. Gordon's book is most interesting and suggestive; the twenty pages show that the writer has not only given great attention to the problems of employment, but has also been in close touch with them in their most important aspects. Mrs. Gordon strongly urges the formation of employment bureaux to give information as to the local prospects of employment, the remuneration offered and prospects of advancement, the qualifications required for the various occupations, and the facilities offered in technical and continuation classes. It is suggested that these bureaux should be managed by committees, on which the education committee, the town or borough council, chamber of commerce, and association of social workers should be represented. We would suggest the addition of employers of labour. A scheme for such a committee is given, from which it appears that the probable cost of a bureau would be between 150*l.* and 250*l.* per annum. For the reasons given above, in addition to those Mrs. Gordon puts forward, we believe that bureaux on some such lines as these will gradually become a necessary part of our educational system.

The remainder and greater part of the book (some 400 pages) is the result of inquiries undertaken in four of the large cities of Scotland as to the conditions of employment in some seventy-six industrial occupations requiring short periods of training, and more than 100 industrial and professional occupations requiring long periods of training. The inquiries were made voluntarily in Glasgow by Mr. R. H. Tawney, an assistant in the Glasgow University, in Edinburgh by Miss Chrystal Macmillan, in Dundee by Mrs. Carlaw Martin, and in Aberdeen by Mrs. Elliot Ogston Clark; and although, necessarily, some of the results are chiefly of local interest, the greater part, with slight modifications of hours and wages, remain true of any district, and the whole forms a most valuable handbook, giving in an easily accessible form the main features of almost every trade and profession.

## OUR BOOK SHELF.

*Self-Instruction in the Practice and Theory of Navigation.* By the Earl of Dunraven, Extra Master. Revised and enlarged edition in three vols. Vol. i., pp. xxvii+272; vol. ii., pp. ix+337; vol. iii., pp. ix+340. (London: Macmillan and Co., Ltd., 1908.) Vols. i. and ii., 17*s.* net; vol. iii., 8*s.* 6*d.* net.

EIGHT years ago the Earl of Dunraven wrote a work in two volumes on the theory and practice of navigation. It was an extraordinary, but in some respects an excellent book. It was extraordinary in the sense that the author had, as he frankly admitted, no great store of information beyond that necessary to satisfy the nautical examiners of the Board of Trade for an extra master's certificate. But if he made little attempt to probe the theoretical principles upon which the practice of navigation rests, he had mastered very thoroughly that portion of the science into which an examiner might inquire. It was an excellent book, because the author knew how to teach; he had the art of successfully conveying to the pupil just that amount of information which would carry him through the ordeal of examination, and we have no doubt that many who write themselves "Extra Masters" are indebted to Lord Dunraven for this qualification. When the choice of a teacher lies between the man of acknowledged mathematical capacity who cannot teach and the indifferently equipped man who can, it is, for the purposes of examination, better to fall into the hands of the man of moderate acquirements.

But there came a time when the Board of Trade raised their standard. As Lord Dunraven puts it, "the Board of Trade in their infinite wisdom decreed that a master mariner . . . must not only be a past-master in the art of navigation, but must also qualify as a naval architect and shipbuilder, be an accurate cartographer, and well advanced in mensuration and mathematics." What was to be done? Lord Dunraven tells us that he does not pretend to be a master of any of these subjects, but he was determined that his book should do for the extra masters of the future what it had done for those in the past, so he heroically mastered the necessary amount of information, increased his book to three volumes, and brought it up to date.

We have no hesitation in saying that the same capacity for imparting the precise information which characterised the earlier edition is equally noticeable in this. The arrangement of the contents is not materially different. In the first volume we have a good deal of elementary preparation that ought to have been acquired in school, and some technical problems, including the use of the compass under various conditions and a review of the law of storms. The second volume is more particularly devoted to the problems of nautical astronomy, which are necessary in order to obtain a master's certificate. In the third volume we climb to that dazzling height the attainment of which entitles the ambitious plodder to the coveted "blue ticket" of an extra master. There are not only a great many examples given the working of which would be advantageous, but many useful hints that it would be unwise for the intending candidate to neglect.

*The London Catalogue of British Plants.* Tenth edition. By F. J. Hanbury. Pp. 48. (London: George Bell and Sons, 1908.) Price 9*d*.

Since the ninth edition of the "London Catalogue" was published in 1895, important events in connection with the nomenclature of British plants have occurred. At the Vienna congress, rules with regard to priority and other matters were framed, and hardly less important for the "London Catalogue" was the publication of the ninth edition of Babington's manual and other special works on British plants. The chief credit for the present revision is assigned to Mr. W. A. Clarke and the Rev. E. S. Marshall, but various specialists have contributed revisions of genera or sections. The number of plants enumerated in the "Catalogue" is appreciably greater than the list issued from the Natural History Museum, since, according to the preface, it aims at providing a useful working list. Although both lists are compiled on similar lines, it will be found that the species under critical genera, such as Ranunculus, do not coincide, whence it need only be concluded that experts still agree to differ.

*Jahrbuch der Naturwissenschaften*, 1907–1908. Edited by Dr. Max Wildermann. Pp. xii+509. (Freiburg: Herdersche Verlagshandlung, 1908.) Price 7·50 marks.

This is the twenty-third issue of a year-book in which progress in various branches of science is described in a series of articles by different authors, with references to the original publications abstracted. The subjects are dealt with under (1) physics; (2) chemistry; (3) astronomy; (4) meteorology; (5) anthropology, ethnology, and archæology; (6) mineralogy and geology; (7) zoology; (8) botany; (9) forestry and agriculture; (10) geography; (11) hygiene and medicine; (12) applied mechanics; (13) technology; (14) miscellaneous reports. In addition, the volume contains summaries of celestial phenomena observable from May 1, 1908, to May 1, 1909, short obituary notices of men of science deceased in the year surveyed, and an author-and-subject index.

The volume should be of service as a general record of scientific work of which accounts have appeared in periodicals and the publications of societies.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

### Prominence and Coronal Structure.

In a paper communicated to the Royal Society in December last (Roy. Soc. Proc., A, vol. lxxx., p. 178), an abstract of which appeared in this journal (vol. lxxvii., p. 314, April 2), I directed attention to a peculiar form of prominence which had been photographed with the spectroheliograph of the Solar Physics Observatory in the "K" light of calcium. This prominence, situated towards the south pole of the sun in the *eastern* quadrant, about position-angle 137°, was recorded on two separate negatives taken at the times 3h. 14m. p.m. and 3h. 50m. p.m. G.M.T. on July 17, 1907. Although on each photograph images of other prominences were recorded, no particular attention was directed to them, as they did not present any unusual features. It may, however, be incidentally remarked that the most intense prominence recorded on both the photographs, and situated near the south pole in the *western* quadrant about position-angle 218°, was reproduced in the paper in Plate iii., Fig. 5. I did not


Fig. 1.—The prominences on the Sun's limb photographed in calcium light on July 17, 1907, 3h. 14m. p.m. G.M.T., at South Kensington.

think it necessary for the purpose of that communication to reproduce the whole limb of the sun, but confined myself to the disturbed area in the south-eastern quadrant. The presence of a large prominence in the south-western quadrant has raised questions of identity, so the complete limb is now here reproduced (Fig. 1) to show the relationship between the two prominences and the sun's south pole.

In April last I received from Mr. Philip Fox, of the Yerkes Observatory, U.S.A., a communication in which he wrote:—

"The large prominence which you discuss certainly has curious form. I have examined my plates for July 17, 1907, and find no prominence of unusual form near the south pole in the eastern quadrant, but there is a beautiful one near the pole in the western quadrant at position-angle 215°. I am wondering if by chance you have given the wrong quadrant and if our prominences are identical. I made my exposure at 5h. 56m. p.m. G.M.T."

On both the Kensington negatives there is a large prominence in the south-western quadrant at about position-angle 218°, and it is intense and shows little indication of diminution in brightness. This is, no doubt, the prominence referred to by Mr. Fox, who gives 215°

as its position-angle; its form has, however, considerably changed in the interval of time between the exposures. Mr. Fox kindly forwarded me a photograph of this prominence, which is here reproduced (Fig. 2), and he oriented it in the corner on rather a small scale. This orientation is reproduced by me on a larger scale in white


FIG. 2.—The large prominence in the south-west quadrant, photographed in calcium light by Mr. Philip Fox on July 17, 1907, at 5h. 56m. G.M.T., at the Yerkes Observatory, U.S.A.

on the photograph. It will be noticed that the upper portion of the prominence is directed from the south towards the west, but in the Kensington photograph (Fig. 1), and also in Prof. Hale's (Fig. 3), the material is directed from the west towards the south. The question arises, is Mr. Fox's orientation right (his position-angle is correct), or has the material altered its position between the times

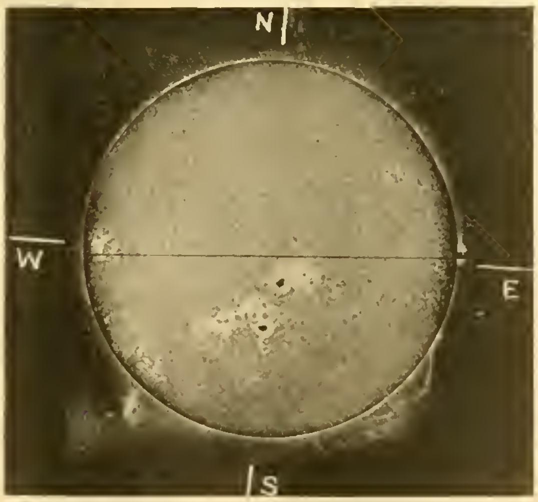


FIG. 3.—The Sun's disc and prominences on the limb, photographed in calcium light by Prof. Hale on July 17, 1907, at 2h. 46m. p.m. G.M.T., at Mount Wilson, U.S.A.

the photographs were taken? I am rather inclined to question the orientation.

Directing attention now to the triple arch prominence about position-angle 137°, which was shown in the first of the Kensington negatives (Fig. 1), I pointed out that in the second photograph, taken thirty-six minutes later, only remnants of the system remained. So rapidly did the whole of this disturbed region wane in intensity that it is not astonishing to hear that two hours later Mr. Fox reported that no prominence of unusual form was there.

The recent communication to this Journal (vol. lxxviii., p. 151, June 18) by Mr. A. A. Buss is of great interest to me, because it made me acquainted with a photograph, secured by Prof. Hale, of the same prominence taken half an hour previous to the first Kensington picture. Through the courtesy of Mr. Newbegin, jun., I received a copy of this very interesting photograph, and one is now able to follow more accurately the sequence of events in the disturbed area. I hope Prof. Hale will forgive me for reproducing his photograph here (Fig. 3), but it is only by showing the two photographs together that a satisfactory comparison can be made. I have ventured to insert the orientation on Prof. Hale's photograph in order to render the identification of the prominences more easy.

The most striking difference between the two photographs is, apart from their form, the great intensity of the large prominence in the south-east quadrant in Prof. Hale's picture (2h. 46m. p.m. G.M.T.) and its comparative faintness in that obtained at Kensington (3h. 14m. p.m. G.M.T.); other prominences are of about the same intensity in each. This diminution of brightness indicates how rapidly the prominence must have waned during the twenty-eight minutes' interval between the exposures. The second photograph taken at Kensington (3h. 50m. p.m. G.M.T.) showed that this rapid waning had continued.

According to Mr. Buss's visual observations, made between 1h. 30m. and 2h. 20m. p.m. G.M.T., *i.e.* before Prof. Hale's photograph was taken, the disturbance as a whole commenced at about position-angle 112°, where an eruptive prominence was situated. The material from this prominence was ejected towards the south pole, dissolving, as he describes, "from a stout, dense and bright stem into a number of bright, more or less parallel layers of striæ." This appearance is shown in Prof. Hale's photograph, but when the Kensington photograph was taken it had assumed the form of concentric arches. These additional facts make me endorse Mr. Buss's opinion, that is, that it is unnecessary to assume that the *material* forming the arch system *originated* from a disturbance below it, or, as I stated in my paper, that "their concentric nature seems to suggest that they were produced at one point of initial disturbance and then moved radially outwards."

It may be added that these new facts in no way invalidate the conclusion drawn in my paper, which was that envelopes, similar in form to those photographed during eclipses, had been recorded in calcium light, thus strengthening the view that they were composed of prominence and not coronal matter.

WILLIAM J. S. LOCKYER.

## Mendelism: a Personal Explanation.

I SHOULD be glad if room could be found for this small matter of personal explanation. I fear I may have misled one or two of your readers on a minor point. Those of them who are interested in the interpretation of hereditary phenomena may remember that in the number of this Journal for September 12, 1907, Mr. Punnett took a reviewer to task for saying that "No one has repeated Mendel's experiments with the deliberate intention of testing the Mendelian interpretation" (of the phenomena of inheritance). In my reply I was not content with defending my original position by justifying that statement; but I must needs carry the war into the enemy's country by taking Mr. Punnett to task for not including de Vries's papers in his list of memoirs dealing with repetitions of Mendel's actual experiments, in order to show how familiar I was with the literature of the subject.

I wish to say that if I had been as familiar with the literature of the subject as Mr. Punnett was, I should not have taken the offensive. Mr. Punnett was quite right in not including a reference to de Vries's papers, because Prof. de Vries, though he has watched the results of crossing in other plants, has not worked with peas. I was misled by the commonly repeated statement that

Mendel's papers were re-discovered, and his results confirmed, at the beginning of this century, by Tschermak, Correns, and de Vries, into believing that de Vries had repeated Mendel's experiments on peas; and I rashly assailed Mr. Punnett for not making any reference to papers which I had not read. Mr. Punnett was therefore entirely in the right, and I was in the wrong.

Mr. Lock has also pointed out to me that an experiment, almost identical with the kind of crucial one which I said ought to be performed, has already been done. I am familiar with the experiment to which Mr. Lock refers (one of his own with maize), and though I regard it as very strong evidence in favour of the Mendelian interpretation of hereditary phenomena, I am sure that Mr. Lock will agree with me that an experiment the results of which will be obtained in September, 1909, is an even more crucial one. A. D. Darbishire.

## THE RESEARCH DEFENCE SOCIETY.

THERE is evidence of a growing feeling among members of the medical profession that the time has come to disperse the atmosphere of mystery which has hitherto attended their ministrations, and to take the public more into their confidence as to the principles on which health may be preserved or regained. They have every reason to believe that the popular ignorance of medical science not only hinders the progress of hygiene and therapeutics, but also is the soil on which quackeries of all kinds grow and flourish, and that the education of the laity in the elementary principles of medicine would conduce to the public health, and at the same time benefit the physician by freeing him from the competition of the incompetent and unscrupulous.

One of the noisiest sections of the opponents of scientific progress is formed by the numerous small societies the object of which is stated to be the further limitation or the complete prohibition of experiments on animals. It might seem that the evidence given before the Royal Commission on Vivisection would suffice to demonstrate the benefits accruing to humanity from the use of this experimental method in the past, as well as to indicate that its prohibition would relegate medicine to the slow advance it made in the Middle Ages. But it is felt that only a small fraction of the public has the courage to seek knowledge in a Blue-book, and that to reach the multitude information must be conveyed in a less unprepossessing guise.

With this object in view, the Research Defence Society has been formed, with Lord Cromer as president, "to make known the facts as to experiments on animals in this country, the immense importance to the welfare of mankind of such experiments, and the great saving of human life and health directly attributable to them." In his letter to the Press announcing the formation of the society, Lord Cromer directs attention to the evidence given before the Royal Commission that "these experiments are conducted with proper care, and that the small amount of pain or discomfort inflicted is insignificant compared with the great gain to knowledge," and states that the society will "endeavour to make it clear that medical and other scientific men who employ these methods are not less humane than the rest of their countrymen, who daily, though perhaps unconsciously, profit by them." With this object the society proposes to publish articles, to give information to all inquirers, and assist all who desire to examine the arguments on behalf of experiments on animals.

The founders of the society ought to be gratified by the success which has already attended their efforts, for it numbers more than 1200 members, of whom 100 are ladies, and this membership has been drawn from all departments of public life, and includes representatives of every class, including many who have taken an active part in the prevention of cruelty to animals. The medical profession is naturally largely represented, but the great number of members who appear to have no direct connection with either medicine or science indicates that there is a wide-felt impression that the methods adopted by the opponents of vivisection are objectionable, and that they have failed to justify their criticisms of this method of investigation.

The society has lost no time in opening its crusade, for we have already received two pamphlets published under its auspices. The first of these comprises "The Evidence of Lord Justice Fletcher Moulton before the Royal Commission on Vivisection" (Macmillan and Co., Ltd.), and the society is to be congratulated on having had this extremely valuable presentation of the principles of the question available as an introduction to its promised series. For, while the other witnesses on the scientific side were by the nature of things compelled to limit their evidence to a detailed account of the methods adopted in their special branches and the results accruing from them, Lord Justice Fletcher Moulton was able to take a wider view, and pointed out with indisputable logic that the experimental method offers the only way to advance in medical as in other scientific subjects. Far from questioning the justification of using animals for experimental purposes, he holds that it is actually immoral to test any method of treatment in man until it has been ascertained as far as possible by investigations on animals that it may be used without injury. As for the suggestion that investigators should experiment upon themselves, he considers that this is to be deprecated except after full investigation by means of animal experiments, not only on account of the danger to the individual subject of the experiment, but because such a procedure tends to lessen the feeling of the sanctity of human life.

The great value of Lord Justice Fletcher Moulton's evidence has been recognised by all who are interested in the subject. He was the only layman who appeared before the Commission in defence of scientific method, and he has presented his views with a cogency which must convince anyone who is capable of following a simple line of argument, and has not abandoned common sense and ordinary logic.

The second pamphlet is by Colonel David Bruce, and is entitled "The Extinction of Malta Fever (a Lesson in the Use of Animal Experiment)" (Macmillan and Co., Ltd.). It forms an admirable complement to the first, for while Lord Justice Fletcher Moulton is largely concerned with the ethical considerations involved in vivisection and the general principles of scientific investigation, Colonel Bruce gives a concise account of one case in which these principles were applied with remarkable and indisputable benefit. Malta fever formerly accounted for about 75,000 days of illness each year in the garrison at Malta, and hundreds of officers and soldiers had to be invalided to England as the result of its ravages. The old statistical methods had been applied for many years, but had failed to give any clue to the cause of the fever, and no improvement resulted from improved sanitation. Finally, the Government induced the Royal Society to send out a commission under Colonel Bruce to investigate the subject, and they soon satisfied themselves by experiments on animals that the cause of the fever is a micrococcus which gains entrance to the human body by means of the goat's milk, which is largely consumed in the island. About half the goats in Malta harboured the microbe, and 10 per cent. of them secreted it in their milk. Measures were at once taken to prevent further infection of the garrison by this vehicle, and the results are strikingly displayed in two charts. In 1905 the number of cases was 643; in 1907, after the preventive measures came into force, seven cases were admitted from Malta fever. Surely further argument is unnecessary to prove the value of the method which can adduce such results.

On June 19 the Research Defence Society held its inaugural meeting in the hall of the Royal Society of Medicine, 20 Hanover Square. There was a very gratifying attendance of members, nearly half those present being ladies. The honorary secretary of the society, Mr. Stephen Paget, read the report of the committee, and stated that he had received a number of letters from members regretting their inability to attend the meeting. The Earl of Cromer, the president of the society, was in the chair, and delivered a very telling speech, which has appeared in the daily Press, and which was directed to show that there is little or no pain inflicted in the methods used in experiments on animals in this country, and that in this way alone is there any prospect of further advance in medicine. The first motion approving of the aims of the society was moved by Sir Thomas Barlow and seconded by Lord Robert Cecil; the second one, approving of the formation of branches, was moved by Mr. Walter Long, who, referring to his experiences in stamping out rabies, stated that he was inspired to do so only by his faith in Pasteur's results, and was seconded by Prof. C. J. Martin. The very successful meeting was closed by a vote of thanks to the president for his speech, and for the keen interest he took in the society, which was moved by Mr. Butlin and seconded by the Hon. Sydney Holland.

## *ARTIFICIAL DIAMONDS.*

FOR some time past the daily Press has been interested in the production of diamonds artificially. Long articles have been written upon the subject, and various persons, scientific and otherwise, interviewed, owing to the prosecution of M. Lemoine by Sir Julius Wernher on account of his failure to produce diamonds by chemical means after he had stated he was able to do so, and, in fact, had promised to produce diamonds of very large size at a price which would compete readily with the natural product. However, after obtaining large sums of money to build a factory, and apparently carrying out experiments in which small diamonds were supposed to be obtained, M. Lemoine entirely failed to produce large ones. When diamonds said to have been produced in the crucibles were critically examined, experts were able, not only to assure the magistrate that these diamonds were not artificial, but were also able in several cases to identify them as stones which had been bought from known sources. The whole case hinged upon a certain envelope which was originally lodged in an English bank, and in which it was stated a formula was contained by means of which diamonds could be produced artificially. On Tuesday, June 16, this envelope was to be opened before the magistrate, but in the meantime the modern alchemist had vanished. When the letter was opened, according to the *Times* of June 18, the following particulars were found:—

"I, the undersigned Henri Lemoine, declare that to make artificial diamonds, it is sufficient to employ the following process:—(1) take a furnace; (2) take some powdered sugar carbon; (3) place the carbon in a crucible; (4) place the crucible in the furnace and raise the temperature to from 1700° C. to 1800° C. in order to obtain crystallisation; (5) when this high temperature has been obtained apply pressure to the cover of the crucible. The diamonds will then be made, and it remains only to take them out."

From this it will be noticed that the formula contains absolutely nothing new; sugar carbon, being the purest form of amorphous carbon, has always been the starting product when any successful attempts to prepare diamonds have been made. Consequently those daily papers which ridiculed the process because of the fact that sugar carbon was one of the ingredients, showed want of knowledge of the subject. However, now that the whole formula is made public, it is, to say the least of it, absurd.

It will be noticed that the carbon is to be placed in a crucible and heated to from 1700° C. to 1800° C., and then pressure is to be applied to the cover of the crucible. When, in 1896, Moissan succeeded in obtaining diamonds artificially, he did subject sugar carbon, when at a very high temperature, to a very great pressure. It will be remembered that sugar carbon was dissolved in molten iron, and the crucible containing this was heated to a temperature of 3000° C. to 4000° C. While at this high temperature the crucible and its contents were plunged into cold water or mercury in order to cause rapid solidification. When carboniferous iron is cooled, it expands in the act of solidifying. By suddenly quenching the iron, a solid layer or crust is obtained outside the molten metal; consequently when the inside layer commences to solidify it expands, and thus, as it is encompassed with a solid crust, enormous pressure is exerted. On dissolving away the iron by means of acids, minute crystals of diamond were produced.

About the same time Marjorana, by heating a small piece of carbon in an electric arc and then suddenly compressing it by driving a piston down upon it with enormous force, the force being produced by firing a charge of powder in the piston chamber (NATURE, June 7, 1900), also obtained minute diamonds.

In 1905 Sir Andrew Noble exploded cordite in closed steel cylinders, when it was calculated that a temperature of 5100° C. was obtained and a pressure of 50 tons per square inch. Sir William Crookes examined some of the carbon deposited, and found it to contain minute diamonds. It would appear, therefore, that M. Lemoine exploited results well known in the scientific world in order to deceive people engaged in the diamond industry.

It is a rather remarkable fact that although amorphous carbon can be converted into graphite, and diamond may also be converted into graphite, as was recently shown by Parsons and Swinton, who obtained graphite from diamond by rapid bombardment with kathode rays, it does not appear possible to convert graphite into diamond. It has been found that when amorphous carbon and graphite are heated to a temperature of 3600° C. in the electric arc in an atmosphere incapable of acting chemically upon carbon, they vapourise without first liquefying, and on cooling condense to form crystals of graphite. Diamond, on the other hand, is first converted into graphite, then vapourises, and on condensation forms graphite. It thus appears that carbon must be in a dissolved condition, and must be cooled under pressure in order for a diamond to crystallise out. Possibly, therefore, we shall never be able to obtain the conditions necessary for producing large diamonds in the laboratory. Low down in the earth's crust carbon may be dissolved in iron or other substances, and may at high temperature be subjected to enormous pressure, such as we, even with the wonderful machinery at our command, and capable of exerting pressures of thousands of tons, have not contemplated. In the earth also the cooling while under this pressure will be slow, and therefore there are the conditions necessary for the growth of large crystals.

Although in nature diamonds are found in pipes of blue clay, this is apparently not the magma in which crystallisation originally took place, for the diamonds may have been forced into the clay by volcanic agencies. Actual blocks of one of the original rocks in which crystallisation took place have been found in blue clay. These blocks consisted of an eclogite containing large quantities of iron, and small diamonds were found, thus suggesting that such was the original mode of formation of the diamond. F. M. P.

## *PICTOGRAPHS OF ARROWS IN FRENCH CAVES.*

THE mural paintings and engravings of the Pyrenean caves is the subject of a series of memoirs by Prof. E. Cartailhac and l'Abbé H. Breuil, now appearing in *l'Anthropologie.* In the current number is an account of the "Grotte des Forges" at Niaux, Ariège. The cave is a narrow gallery more than 1400 m. in length, with several short branches; at 611 m. from the entrance a broad lateral gallery runs due south for a distance of 160 m., and terminates in a rotunda, the walls of which are decorated with bisons, horses, deer, wild goats, and groups of signs. There are no designs of animals in the first half of the main gallery, and only five at long intervals in the second. The authors write with enthusiasm concerning the rotunda. The paintings possess to a supreme degree the style of the period, and represent the same animals that were familiar to the Palæolithic artists of the Pyrenees, the bisons being in the great majority. The drawings, which represent animals in profile, are drawn with a brush in black pigment with a sure and exact touch, and the characteristic traits of the animals are conscientiously delineated. The best polychrome frescoes are to be seen in the caves at Altamira, in Spain, but Niaux is unexcelled in its line work. The black pigment consisted of a mixture of charcoal and oxide of manganese worked up with grease.

Bison in the Salon noir of Niaux transfixed by three arrows.

Perhaps the most important new feature of the Niaux pictographs is the representation of arrows sticking into many of the animals, thus conclusively proving the existence of the bow and arrow at this early period. The accompanying figure represents a large bison with four arrows, the two lateral being red in colour. Some of the animals are marked by a spot, which may be intended to represent a wound.

A lamp placed on the ground in a corner of the rotunda or "salon noir" revealed, by chance, a series of engravings on the firm clay soil of the cave. The same animals that were painted on the walls were also engraved on the ground. The drawings were of the same style, and some of the animals were pierced with arrows. But it was only on the ground that designs of fish occurred, one of which, 30 cm. in length, is readily recognised as a trout. Even some impressions of the naked feet of the artists were still visible. Of definite objects very little has as yet been discovered, only one small flint scraper of characteristic Palæolithic type, and fragments of bones, pieces of yellow ochre, and ashes. To execute the painting the Cave-men must have had artificial light of some sort.

The sign-pictographs are obscure in their significance. Some look like feathers with long quills; possibly they are arrows, in which case the arrows were feathered. There are several straight or slightly curved broad lines, from near the end of which a prominence is depicted; these appear to represent stone implements let into a thick stick. Other sticks or clubs are straight or slightly curved; these the authors regard as boomerangs. Other markings consist of lines or groups of spots, some of a red colour arranged in a circle surrounding a central spot. These recall the markings on the coloured pebbles of the famous cave of Mas d'Azil.

These discoveries by our French colleagues are shedding welcome light upon the life of the Palæolithic cave-dwellers of western Europe, but doubtless more information will come to hand when the investigation of the wonderful French caves is completed.

A. C. H.

## *NOTES.*

SIR GEORGE DARWIN, K.C.B., F.R.S., has been elected a foreign member of the Amsterdam Academy of Sciences.

THE "Società italiana delle Scienze (detta dei XL.)," of which Prof. Cannizzaro is president, has elected Sir William Ramsay as a foreign fellow (Socio straniero).

THE annual conversazione of the Royal Society of Arts will be held at the Natural History Museum, South Kensington, on Thursday next, July 2.

WE learn from the *British Medical Journal* that Prof. Grassi, whose name is well known in the scientific world in connection with research on malaria and other subjects, has been created a Senator of the kingdom of Italy.

THE annual meeting of the Victoria Institute will be held at Burlington House on Wednesday, July 15. The chair will be taken by the president, the Earl of Halsbury, F.R.S., and an address will be given by Mr. E. Walter Maunder.

THE council of the Royal Society has awarded the Mackinnon studentships for the year 1908 as follows:—one in physics to Mr. J. A. Crowther, of St. John's College, Cambridge, for an investigation of the passage through matter of the $\beta$ rays from radio-active substances; one in biology to Mr. D. Thoday, of Trinity College, Cambridge, for a research into the physiological condition of starvation in plants and its relation to the responsiveness of protoplasm to stimulation, especially to stimuli affecting respiration.

MR. A. G. BAGSHAWE, the director of the Sleeping Sickness Bureau, who can be addressed care of the Royal Society, Burlington House, London, W., desires it to be known that he will be glad to receive reprints of any papers dealing with sleeping sickness, trypanosomiasis, and cognate subjects, and, indeed, any information relating to the work of the bureau.

REUTER'S Agency learns that a fresh commission is being organised to proceed to East Africa to study sleeping sickness, its object being to continue the work carried on from 1902 until it was temporarily suspended in 1905, owing to the death in England of Lieut. Tulloch, who contracted sleeping sickness during his researches in Uganda. The new commission will be in charge of Colonel David Bruce, C.B., F.R.S., and, on September 25, will proceed from England, *via* Mombasa, to Lake Victoria, on the northern shores of which the Uganda Protectorate is preparing a laboratory in the province of Chagwe, two miles from the lake, for the purposes of the investigation. The spot chosen will be within five or six miles of one of the concentration camps organised by the Government, where sleeping sickness patients are under treatment. The work of research will include the study of the natural history of the fly, and also of Dr. Koch's theory that crocodiles provide foodstuffs for the *Glossina palpalis*. The commission will also investigate the question whether the lower animals harbour the parasites, and the exact method by which the fly transfers the parasite.

WE regret to announce that Prof. W. R. Cassie, professor of physics at the Royal Holloway College for Women, Egham, and honorary secretary of the Physical Society, died suddenly on June 22. Prof. Cassie, who was born at Fraserburgh in 1861, was educated at Aberdeen University and Trinity College, Cambridge. He was Clerk-Maxwell student of experimental physics at the Cavendish Laboratory from 1891–3; a Cambridge University extension lecturer from 1888–93; Thompson lecturer on natural science, Free Church College, Aberdeen, 1893–4; and in 1893 was appointed to the chair of physics occupied by him at the time of his death.

MR. GEORGE SIM, author of "The Vertebrate Fauna of Dee," died at Aberdeen on June 15 at the age of seventy-three. He was a fine type of the self-trained naturalist, and made many interesting contributions to faunistic zoology. His knowledge of British birds, fishes, and crustaceans was very wide and accurate, and he was remarkably disinterested and generous in placing both specimens and information at the disposal of serious workers. He pursued several lines of inquiry into great detail, having, for instance, a quite extraordinary knowledge of the specific characters of fish-scales. He gave some of his collections to the University of Aberdeen.

THE committee of the Lawes Agricultural Trust held its annual meeting for the inspection of the Rothamsted Experimental Station on June 19. A vote of condolence was addressed to Lady Evans expressing the sympathy of the committee in the loss she had sustained through the death of Sir John Evans, who had been chairman of the committee since the foundation of the trust, and to whose endeavours the organisation and extension of its work had been so largely due. In the afternoon the laboratory and field experiments were inspected.

THE council of the Royal College of Surgeons has given permission to Dr. Elliot Smith and Dr. Wood Jones, of the Cairo Medical School, to carry out, in the museum of the college, an examination of a collection of material found during excavations in the Nile Valley. The material is representative of peoples inhabiting Nubia in ancient times, and is expected to throw light on their pathology and the results of their surgery. The Egyptian Government has expressed its willingness to present the collection of specimens to the museum of the Royal College of Surgeons, and the council has accepted the offer.

QUEEN'S UNIVERSITY, Ontario, has received as a gift from Dr. J. P. Thomson, hon. secretary and treasurer of the Royal Geographical Society of Australasia, Brisbane, a large and valuable collection of specimens for its museum. The collection, which is typical and widely representative, consists of no fewer than 457 ethnological specimens and 140 shells of different kinds from Polynesia, New Guinea, and Australia, many of the specimens being very rare. Dr. Thomson is also sending to the University a large collection of economic minerals, a great number of additional ethnological specimens, some rare birds' skins from New Guinea, and many Queensland butterflies and moths. The thanks of the University have been conveyed to Dr. Thomson, whose valuable gifts are deeply appreciated.

THE Society of Mineral Industry, the most important mining and metallurgical institution in France, celebrated at St. Etienne on June 14–20 its jubilee by a very successful congress, which was attended by 436 engineers from the various mining and metallurgical districts of France. Mr. L. Tauzin, inspector-general of mines, presided; and papers were read by Messrs. Siegler, Vicaire, Bureau, Marsaut, Laur, Fayol, Rateau, de Renéville, and Lemière. Visits were paid to the principal collieries and steelworks in the district. At the banquet on June 17 gold medals were presented to Messrs. Marsaut, Rateau, Fayol, Pourcel, and other distinguished members of the society who had done most for mining and metallurgy during the past fifty years, and congratulatory addresses were presented by Mr. Bennett H. Brough on behalf of the Iron and Steel Institute, and by Mr. Hedley on behalf of the North of England Institute of Mining Engineers.

AT the annual general meeting of the Linnean Society of New South Wales, held in March last, Mr. A. H. S. Lucas delivered his presidential address, taking as his special subject the relations of science and government. Having advanced to his present position in the provinces of nature, man must, he said, fortify the position he has won, and must advance by utilising the knowledge which workers in science alone can provide. This essential fact, he maintained, is not sufficiently recognised by the public or by politicians. The appreciation by Australia of the modern point of view is, he urged, of great importance, because she has begun to learn through the pocket the costliness of ignorance. The Government alone can watch over the permanent interests of the State and see that resources are not impoverished. The scientific method, the method of accurately informed common sense, is the only efficient method in government as in everything else. Science is the natural ally of government. In regard to material questions, the man of science of the twentieth century occupies the position of the prophets of old. Without science no nation can keep its place in the van, for "science is the golden guiding star of practice; without science there can only be a blind groping in the region of undefined possibilities."

WE have to acknowledge the receipt of three papers issued by the University of California, the first of which, by Mr. J. C. Bradley, is devoted to two species of amphipod crustaceans of the genus Corophium from the Pacific coast. The other two, by Mr. C. A. Kofoid, deal with the pelagic unicellular organism Ceratium, more especially from the point of view of exuviation and regeneration.

ACCORDING to the "Aarsberetning" for 1907, the authorities of the Bergen Museum are devoting special attention to the exhibition series, which is being developed much on the lines of our own Natural History Museum. Several of these new exhibits are illustrated by reproductions from photographs, and among them, judging from these illustrations, may be specially commended a pair of bar-tailed godwits with their young, and the head of a rorqual.

The history of the Hancock Museum at Newcastle-on-Tyne forms the subject of an article by the curator, issued as an appendix to the Transactions of the well-known northern natural history society. A feature of this institution is that it is owned and maintained by the society, and therefore costs nothing to the ratepayers. The maintenance of such a large institution naturally imposes a heavy burden on the society, the efforts of which in other directions are in consequence somewhat crippled. On the other hand, the society enjoys the advantage of complete and unfettered control of a number of valuable collections which have from time to time been consigned to its custody. The article is illustrated with two views of the museum, together with portraits of Joshua Alder, Albany and John Hancock, and Thomas Atthey.

We have been favoured with a copy of the first number of the Annals of the Transvaal Museum, at Pretoria, which contains an illustrated account of the origin, progress, and present condition of that institution, together with several papers on the zoology and botany of the Transvaal. The fauna of South Africa is illustrated in a series of saloons specially devoted to that purpose, while other saloons contain the mammals, birds, fishes, &c., of other parts of Africa and the world generally. So far as can be gleaned from the photographs, many of the larger mammals appear to be well mounted, and it is satisfactory to learn that the collection includes a fine example of the white rhinoceros. The museum was founded in 1892, on the initiative of Dr. W. J. Leyds, and since that date appears to have made remarkable progress, although its development is hindered by lack of sufficient funds and space.

In the course of his presidential address to the South London Entomological and Natural History Society, as reported in the Proceedings of that body for 1907–8, Mr. Robert Adkin directed attention to the advantage accruing from federation among local scientific bodies. The Yorkshire Naturalists' Union set the example of such federation so long ago as 1862, with the result that while numerous advantages were found to follow, no harm was done to the local work of the various bodies which constitute the union. In 1896, at the invitation of the Tunbridge Wells society, the South-eastern Union of Scientific Societies was established, as the result of which it has been found practicable to hold an annual congress at one of the towns within the area covered by the union, to the great advantage of the members. Nor was this all, for in the shape of the *South-Eastern Naturalist* the union publishes a journal which deservedly occupies a high position among literature of this class. The success of this southern federation is indicated by a proposal that the local societies of Essex and Hertfordshire should be eligible for admission to the union.

The eighth part of vol. iv. of the Annals of the South African Museum contains no less than five papers by Dr. R. Broom on the Permo-Triassic tetrapodous vertebrates of the country. In the first the genus Propappus, originally named from a single limb bone, is stated to be distinct from Pariasaurus, having, among other peculiarities, a dermal armour on the spinal region. New generic types of the carnivorous groups are also described, and it is pointed out that the difference in the structure of the palate between the Permian and the Triassic representatives of these reptiles amply justifies their separation into distinct groups. While the latter, as typified by Galesaurus, have a typically mammalian secondary palate, that region in the former is a modification of the type obtaining in rhynchocephalian reptiles. For these two groups Dr. Broom employs the names Cynodontia (=Theriodontia) and Therocephalia. In the last of the series the author assigns certain Cape labyrinthodonts (one of which had been referred to the American Eryops) to the new genus Rhinesuchus, of which, however, the type is a German species.

Mr. T. Sheppard, curator of the Hull Museum, has issued another of his useful penny booklets, in which he discusses prehistoric remains from Lincolnshire, and fish and other remains from the Chalk of Lincolnshire and Yorkshire. These relics are mostly of the Bronze age; a few are Neolithic, but Palæolithic man is apparently not represented in this part of the country. They include some fine cinerary urns and an "incense cup" from a tumulus at Kirton Lindsey; and some stone implements, such as a perforated adze axe-hammer, from the Drift. One remarkable perforated adze is suspected to be the handicraft of the notorious Flint Jack. From Burton-on-Humber come a fine bronze palstave and two imperfect axes, probably rejected failures from a founder's horde. The fossils include those of ganoid and teleostean fishes, as well as selachians from the well-known chalk quarries at Barton and South Ferriby. Mr. Sheppard's careful examination of these relics, of which his pamphlet contains good illustrations, supplies an excellent example of the class of work which a local museum under competent management can usefully prosecute.

Dr. R. Semon contributes to the *Biologisches Centralblatt* (April 1) an article on the effects induced in plants by alternations of light and darkness, and the question originally investigated by him whether these effects are transmitted to plants of a subsequent generation. He directs particular attention to the facts that he experimented with seedlings of *Albizzia lophantha*, and used a very weak stimulus.

Attention is directed in the report for 1906–7 on the botanical and agricultural establishments of Antigua to the advantages derived by the presidency from the working of the Imperial Department of Agriculture for the West Indies. In addition to the re-establishment of an efficient botanic station and a revival of the decadent sugar industry, the Department has fostered agricultural education and has developed an appreciable cotton trade. In connection with sugar, it is noteworthy that two central factories are in operation. Reference is made in the report to the celebration of arbor day, when two hundred trees, largely mahogany, were planted. It is noted that for hedges *Malpighia glabra* and logwood, *Haematoxylon campechianum*, have been found useful.

It will probably be unknown, even to some bamboo fanciers, that certain bamboos in Japan have a special value because they are flecked or coloured. Where the effect is a natural one, it is generally due to lines or stripes of a colour differing from the general ground colour; in other cases the figuring is produced by fungi. Instances of the latter are furnished by a Chinese undetermined species of Phyllostachys and the Japanese plant, *Arundinaria Narahira*. An account of the latter and the parasitic fungus *Miyoshia fusipora* is contributed by Mr. S. Kawamura to the Journal (vol. xxiii., art. 2) of the Royal College of Science in Tokio. Artificial sowings on the bamboos were not very successful, but conidia, perithecia, and ascospores were obtained in cultures, as a result of which the fungus is made the type of a new genus, allied to Trichosphæria, of the order Sphæriaceæ. The bamboos are converted into walking-sticks, flutes, and small articles.

In connection with an article on the "Pigmentation Survey of Scotland," which appeared in Nature of May 21 (p. 68), Mr. J. F. Tocher requests us to state that the survey, which was carried out under the supervision of a committee consisting of Sir W. Turner, Prof. R. W. Reid, Mr. J. Gray, and himself, has up to the present extended only to school children—one-eighth of the total population; that his share in Mr. Gray's report, published in the Journal of the Royal Anthropological Institute, and noticed in Nature, was confined to supplying a key map and some statistical tables; that he is not responsible for the views expressed in Mr. Gray's article; and that a complete account of the results, with the conclusions which he has drawn from them, is in the press, and will be published at an early date.

The methods of manufacture of the remarkable Malaita shell bead money current in the Solomon group are described by Mr. C. M. Woodford in the June number of *Man*. Of this there are three varieties:—white, made from the shell of *Arca granosa*; red, from that of *Chama pacifica*; black, from a large black mussel or pinna. The shells are first broken into irregular fragments about the size of a threepenny piece. They are next chipped into the form of a roughly circular disc, in diameter about as large as a pea. Finally, these are ground into shape on a stone, the fragments being fixed on the flat surface of a piece of soft wood of semicircular section. This stone is so rare and valuable that Mr. Woodford was able to secure only a few pieces. After being pierced by means of a pump drill, the beads are threaded on strings, each a fathom or about 5 feet long, the character and colour of the beads determining their values as currency.

An admirably illustrated description of the Federal Fuel Testing Laboratory at Zurich is given by Prof. E. J. Constam in the *Engineer* (vol. cv., p. 618). The laboratory was started in 1906, and has already done much to ensure that Switzerland receives the proper equivalent for the 3,000,000*l*. annually expended on imported fuel. In the first year of its existence, besides research work, more than 3300 samples of coal and briquettes were examined. Most came from Germany, and the rest from Belgium, France, and England. This extensive examination of imported fuels has tended to enlighten the consumers as to the qualities and economic value of the fuels from the various countries and collieries, and has contributed towards their classification according to heating power. It is to be hoped that before long this latter will be universally adopted for the basis of coal contracts, instead of the vaguely defined evaporation power, or the percentage of combustible matter.

From the Pulsometer Engineering Co., Ltd., we have received a catalogue of pulsometers which, in that it contains a detailed description of the working and of the various applications of this useful form of steam pump, is of greater interest than the usual type of manufacturers' price-list. The pulsometer will pump dirty water, it has no moving parts except the valves, it disposes of its own exhaust steam, it can be supported on its suction pipe or slung from a chain. In short, it is essentially a pump that will stand rough usage, and requires no skilled attention. In these circumstances the useful services it is capable of rendering are evident, and the variety of applications of the pulsometer are well shown in the excellent illustrations given in the catalogue.

We are indebted to Prof. G. Platania for an interesting pamphlet (reprinted from the *Annuario* of the R. Nautical Institute of Catania, 1908) on the determination of wind direction and force at sea, and on the Beaufort scale. The author quotes the results of various comparisons of wind-force estimated by the latter method with the records of anemometers both in this country and abroad, and especially the recent elaborate discussion by Dr. Shaw and Dr. Simpson (Meteorological Office Publication, No. 180, 1906). The author also quotes a useful modification of the scale, suggested by Commander Hepworth, in view of the changed conditions due to the use of steam and to the rig of modern sailing vessels since it was devised by Sir F. Beaufort in 1806. Prof. L. Marini proposed an elegant method of finding the true direction and velocity of the wind from the speed of the ship and the direction of the apparent wind, without reference to its velocity (*Rivista Geogr. Ital.*, 1907), which, although worthy of being known, is not very easy of practical application. Prof. L. Rotch's ingenious instrument, made by Casella, of London (Quart. Journ. R. Meteor. Soc., 1904), is admitted to be more useful in practice.

The values which have been obtained for the molecular weight of the radium emanation have been based on observations of the rates of diffusion of the emanation and of various gases in the same circumstances. According to Graham's law, the molecular weights should be inversely proportional to the squares of the rates of diffusion, but the values of the molecular weight of the emanation calculated on the assumption of the truth of this law have differed widely from each other. Rutherford and Brooks obtained a number between 44 and 74, while Bumstead and Wheeler more recently found a value about 180. Mr. P. B. Perkins, of Yale, has just completed a comparison of the rates of diffusion of the emanation and of mercury vapour through a porous plug, and publishes his results in the June number of the *American Journal of Science*. He concludes that the molecular weight of the emanation exceeds that of mercury, and probably differs little from that of radium, 227.

Although much has been written on the theory of the Ruhmkorff coil, the simpler single circuit induction coil, so much used in these days to ignite the explosive mixture in gas and petrol engines, has received little attention, and no accurate measurements of its efficiency have been made. The *Physical Review* for May contains an article on the subject which is probably the first ever published. It is from the pen of Mr. B. F. Bailey, and includes both a theoretical treatment and a comparison of theory with experiment. In the case of one of the coils tested the efficiency, that is, the ratio of the energy of the spark to that supplied to the coil, was 54 per cent., while the calculated value was 56 per cent., and the author shows how, by cutting down the time of contact, the efficiency of the coil was raised to 85 per cent.

The Philosophical Institute of Canterbury is one of the district institutes affiliated to the New Zealand Institute, and is devoted, among other works, to the encouragement of science. It was founded in 1862, and though undergoing many vicissitudes since that date, it has had a continuous existence, and has numbered among its members most of the residents of Canterbury interested in science. The institute holds regular monthly meetings from May to

December, and a syllabus for the present year has been received. Among subjects to be dealt with this session we notice Mendel's law of heredity, physical and geological problems suggested by the construction of the Arthur's Pass Tunnel, bird life in New Zealand, and Antarctic exploration. The council of the institute has in hand the publication of reports that will be made on the collections secured during the recent sub-Antarctic expedition to the Auckland and Campbell Islands, and has taken steps to secure the proper investigation of scientific questions which will be raised by the boring of the Arthur's Pass Tunnel. Mr. E. G. Hogg, of Christ's College, is the president of the institute; Mr. R. Speight, of Canterbury College, the honorary secretary; and Dr. Chas. Chilton, of Canterbury College, the honorary treasurer.

The issue of *Science* for June 5 contains an interesting symposium at the Illinois State Academy of Science on the opportunities for American young men in science. Prof. J. G. Coulter deals with the opportunities available in botany, Prof. W. A. Noyes with openings for chemists, Dr. H. Foster Bain with the outlook in geology, Prof. H. Crew that in physics, and Dr. H. V. Neal that in zoology. There is a fair unanimity among the contributors that the young man whose primary object is to make money should not select as his life's work the pursuit of pure science. It is curious to remark that Prof. Coulter referred to the lack of interest in science on the part of the American public, and traced it to the same cause as was suggested in the *Times* correspondence arising out of the speeches at last year's Royal Society dinner to account for the similar apathy in this country, that American men of science rarely make it their duty properly to popularise the problems on which they are at work. Prof. Coulter stated that in America the demand for trained botanists continues to exceed the supply. Prof. Noyes estimated that there are about 8000 chemists in the United States, and concluded by saying that the demand for chemists to fill positions in connection with the bureau of chemistry has largely exceeded the supply of suitable men. Dr. Bain made it clear that it may be taken for granted that properly equipped and willing workers in geology may rest assured of positions being open to them. Prof. Crew summarised the opportunities for young men in physics under the headings of research, applied physics, engineering, and teaching, and spoke very hopefully of the outlook in each of these directions. Dr. Neal said, so far as zoology is concerned, that the chances for getting good zoological positions have much improved during the last ten years. Though there is this increased demand, there has been no increase in the supply of men to fill the posts. New fields for employment are being opened, and there is every possibility that the present demand for zoologists will be maintained.

Prof. E. B. Poulton's "Essays on Evolution" are to be published by the Oxford University Press on July 1, the fiftieth anniversary of the meeting of the Linnean Society at which was read the joint essay on natural selection by Darwin and Wallace. The ten essays cover the period 1889–1907.

Messrs. E. and F. N. Spon, Ltd., have published, at 4*d*. net, tables of logarithms, antilogarithms, useful constants and the functions of angles, taken from the examination tables of the Board of Education. The tables are mounted on linen, and so folded that they will go into the pocket easily; they can be opened out in such a way that the logarithms and antilogarithms can be examined side by side.

The first part of the "International Geography" by seventy authors, edited by Dr. H. R. Mill, has now been published separately by Messrs. Macmillan and Co., Ltd., at 1*s*. 6*d*. This section, which deals with the principles of geography, is the eighth portion of this standard book to be issued in a convenient separate form, and at a price which makes it available as a class-book in schools. These parts of the "International Geography" deserve to be widely used in schools where the study of geography is taken seriously.

We have on previous occasions directed attention to the medical and scientific circulating library conducted by Mr. H. K. Lewis, of Gower Street, London, W.C. The new edition of the library catalogue, revised to the end of 1907, has been published recently at a price of 2*s*. net to subscribers and 5*s*. net to non-subscribers. The catalogue shows that the student and man of science may here obtain the advantage of a very large collection of modern medical and scientific text-books and special monographs. In addition to books on pure and medical science, works on different branches of engineering science and general technology are included. Not only are the books classified under their authors' names, but they are also conveniently arranged in a second section according to subjects.

## OUR ASTRONOMICAL COLUMN.

The Rings of Saturn.—In a note published as Bulletin No. 32 of the Lowell Observatory, Prof. Lowell develops rather more fully the idea that the appendages B and C of Saturn are not flat rings, but tores. He arrives at this conclusion, by two independent methods, from a discussion of the phenomena observed at Arizona during November and December last. In the first place, a black core was observed running medially through the length of the shadowy band which then encircled the planet. This core was seen by all the observers at Flagstaff, although not caught by Prof. Barnard at Yerkes nor reported in the Lick observations, and is presumed to be the black shadow of the plane ring A bordered by the particles of the rings B and C scattered above and below the plane of A. That is to say, the rings B and C differ from A in being tores and not flat rings. Then the agglomerations, seen at many different observatories, are shown to be better accounted for by Prof. Lowell's theory of the form of the rings than by the several other theories which have been proposed. An analytical discussion of the perturbing effects to which the ring matter is subjected by the satellites, &c., shows that the assumed heaping up of the particles, as indicated by the agglomerations, is in accordance with gravitational laws. Furthermore, it is shown from the observational results that the inevitable disintegration of the rings is in the process of taking place.

The Forty-inch Objective of the Yerkes Observatory.—An interesting paper by Mr. Philip Fox, giving the results of an investigation of the 40-inch objective of the Yerkes Observatory, appears in the May number of the *Astrophysical Journal* (vol. xxvii., No. 4, p. 237). The tests, in the first instance, were carried out at the suggestion of Prof. Hartmann, who is desirous that the data might be published for every objective in active use, but they have been extended and comprehensively discussed by Mr. Fox. The method employed was that of the "zonal test," using a perforated diaphragm having sixty holes, each of 2 cm. diameter, located at the corners of squares on fifteen different zones. Briefly, the results indicate, *inter alia*, that the centre of the Yerkes objective is of appreciably shorter focal length than the edge. The variations come, however, well within the limits for which Prof. Hartmann classifies an objective as "preeminently good." Plates taken at varying zenith distances appear to indicate that the performance of the objective varies with the zenith distance, and, should this be confirmed, it appears certain that, even could the mechanical difficulties of construction be overcome, refractors of greater dimensions than the 40-inch cannot be constructed with the hope of uniform performance at all altitudes.

The same journal contains a discussion by Prof. Hartmann of an improvement of the Foucault knife-edge test in the investigation of telescope objectives.

THE TEMPERATURE OF THE SUN.—In a preliminary note, now published as an abstract from the *Annalen der Physik* (vol. xxv., pp. 905–20, 1908), Dr. Goldhammer discusses anew several sets of results obtained in the determination of the temperature of the sun. From the discussion of Langley's various observational data he arrives at the conclusion that the probable actual temperature of the sun is not less than 10,000° absolute.

THE VARIATION OF THE POLE.—Prof. Albrecht's annual summary, for 1907, of the provisional results derived from the observations made at the various international latitude stations appears in No. 4253 of the *Astronomische Nachrichten* (p. 73, June 5). The extrapolated values for the variation, in the several coordinates, for 1908·0 are:— $x = -0''\cdot097$, $y = +0''\cdot185$, and $z = +0''\cdot012$. The curve showing the departure of the pole from the mean position between 1899·0 and 1908·0 shows that the value of the $y$ variation at the commencement of the current year was approaching the maximum observed during that period.

OBSERVATIONS OF THE PERSEID SHOWER IN 1907.—No. 4253 of the *Astronomische Nachrichten* (p. 83, June 5) contains a note by Prof. J. Sykora in which are given the results of the meteor observations made at Tashkent and Iskander during the nights of August 10–12, 1907; Iskander lies about 44 kilometres to the north-east of Tashkent. From the recorded paths of 178 Perseids the centre of the radiant of the shower, for 1907, was found to be $\alpha = 42°\cdot7$, $\delta = +53°\cdot8$, and the area covered by the radiants lay between 31° and 55° in R.A. and +49° and +59° in declination. The calculation of the altitudes showed that the mean heights of appearance and disappearance were 167 and 96 kilometres respectively. The trails of nine meteors were photographed, and brief descriptions of trails are given in the paper; several of them indicate marked variations of brightness during the meteor's flight.

## *RECENT DEVELOPMENTS IN ELECTRIC LAMPS.*

IN an article which appeared in NATURE last June the present writer reviewed briefly some of the improvements which had been made and promised in incandescent electric lamps. At the time that article was written, matters were in a condition of considerable uncertainty on account of the great number of new developments which had been announced, the value of which was, to a very large extent, uncertain. The frequent announcements of these improvements, which were appearing almost weekly, led electrical engineers to feel considerable hesitation in adopting any new lamp for fear that it should be superseded almost immediately after its adoption. Since that time the position has become much quieter, and during the past six months the solid progress which has been made in the introduction of these lamps on the market has been remarkable. Now that considerable experience has been obtained of the practical working value of the different types of lamp, a favourable opportunity is afforded of taking a general survey of the present position and prospects for the future. At the same time, a similar survey may be taken of the conditions existing in the field of arc lighting, in which the developments during the past two or three years have been almost equally noteworthy.

### *Incandescent Lamps.*

As was pointed out in the article referred to above, the only two lamps which appeared to merit particular attention were the tungsten and the tantalum lamp. The tantalum lamp has now been in practical use for about two years, and has not undergone any appreciable modification since the time of its first introduction. Difficulties of producing a satisfactory lamp for use with alternating current are still not overcome, and the difficulties of drawing tantalum wire sufficiently fine to enable either low candle-power low-voltage, or medium candle-power high-voltage lamps to be produced still await practical solution. It is true that the range of candle-power with low-voltage lamps has been extended by the introduction of a 16-candle-power lamp, and that announcements have been made from time to time that a satisfactory solution has been found for the manufacture of high-voltage lamps. The fact remains, however, that high-voltage lamps are not yet produced commercially. The tantalum lamp has satisfactorily proved its value for electric lighting. Although the general results obtained seem to show a comparatively short average life of about 700 hours, and though the efficiency is approximately only half that of the newer tungsten lamp, it is apparent that this lamp will have to be reckoned with for some time to come as a very important factor in the field of incandescent electric lighting. Though it may not be able to compete on the score of efficiency with the tungsten filament, yet the greater strength of the filament must always operate to counterbalance these disadvantages.

The tungsten lamp, ever since its commercial introduction into this country under the name of the "Osram" lamp by the General Electric Company, has made rapid strides in popularity. Considering that the lamp has only been on the market for a matter of about nine months, its very widespread use at the present time must mark almost a record in the development of electric lighting. In its practical performance, also, this lamp has fulfilled, or more than fulfilled, the hopes which were raised for it before its introduction. Beyond the blackening which occurs with a small percentage of these lamps, the general experience is that a life of 1000 to 1500 hours is obtained almost without any decrease in the initial efficiency of about $1\frac{1}{4}$ watts per candle. This blackening appears to be a defect in manufacture which will doubtless be soon overcome, since it is not a characteristic of all lamps, but is only observed in a very small percentage, which generally show this defect almost immediately they are put into use. The tungsten lamp has hitherto possessed the disadvantage, when compared with its tantalum rival, that it could only be used in a vertical position, but a modified type has just been introduced which can be burnt at any angle. On the other hand, the tungsten lamp has the advantage that it is suitable for use on either direct- or alternating-current circuits. Up to the present, the range of voltage for which the lamps can be made is practically the same as that for the tantalum lamps, viz. voltages up to 130, but the tungsten lamp has not yet been made for voltages of 100 in such low light units as the tantalum lamps, the lowest at present obtainable being approximately thirty candles. Tungsten lamps have also been made, but not yet commercially introduced, for high voltages (200 and above), and the introduction of a 40-candle-power lamp for 200 volts is promised very shortly.

It is yet too early to say precisely what will be the effect of the introduction of these two lamps on electric lighting in general. At present, for the most part probably, the lamps have been used for the lighting of factories, shop windows, and public or semi-public places where costs of lighting are very closely considered and artistic effects are of secondary importance. It is perhaps not safe to argue from the success which the lamps have attained in the past year for these purposes that they will meet with corresponding success in private house lighting, especially as in that case the size of the light unit becomes of much greater importance. It is more than probable, however, that the general public will welcome the higher light units if they provide them, as these lamps do, with a means at the same time of actually reducing their lighting bills. The present writer, for example, has substituted two 32-candle-power Osram lamps for a single 16-candle-power carbon filament lamp, and finds that it has resulted in actual saving in money in spite of the fact that four times as much light is obtained. It is noteworthy that the fears which were expressed that the difficulties in running lamps in series would very seriously affect the introduction of metal filament lamps do not appear to have been well founded.

Beyond these two types of lamp the development in incandescent lighting has been slight. The exceedingly interesting discovery (from a scientific point of view) by the General Electric Company in America of a method for radically altering the nature of the carbon filament unfortunately came too late to have any practical effect. These so-called "metallised" filament lamps, had they come four or five years ago, would have been welcomed as a great step in advance, but coming as they have at the same time as the metallic filaments, are practically doomed to failure, since they possess the same disadvantages, and, in addition, can only be worked at an efficiency of $2\frac{1}{2}$ watts per candle. The same may be said of the Nernst lamp, which is almost bound to give way in the sphere of incandescent lighting to metal filament lamps. It is possible that the Nernst lamp will find a sphere of its own for intermediate lighting where light units of 100- to 200-candle-power are required, but it is much more probable that it will be ousted also from this field by the high candle-power metal filament lamps.

*Arc Lamps.*

The remarkable change in the prospect of incandescent lighting which has been effected by the introduction of the metal filament lamp has been paralleled by a similar change in arc lighting by the introduction of flame lamps. The gain in efficiency in a metal filament lamp over a carbon filament lamp is approximately three times, and an almost similar gain is obtained in a flame lamp over an ordinary open type arc lamp. The idea of introducing chemicals into the arc in order to colour the flame is an exceedingly old one, but the practical solution was not obtained until Bremer brought out his mineralised flame carbons. The carbons introduced by Bremer were mineralised carbons in which the flame-producing material was intimately mixed with the material of the carbon rod itself. Alterations were later effected by the various carbon manufacturers by which the flame-producing material, instead of being introduced into the main body of the carbon, was only introduced into the core. This latter type of carbon is by far the most common, but carbons of the Bremer type are still in use, and have been considerably improved recently by M. Blondel, who claims to have succeeded by their employment in producing a far more efficient lamp than the ordinary flame lamp.

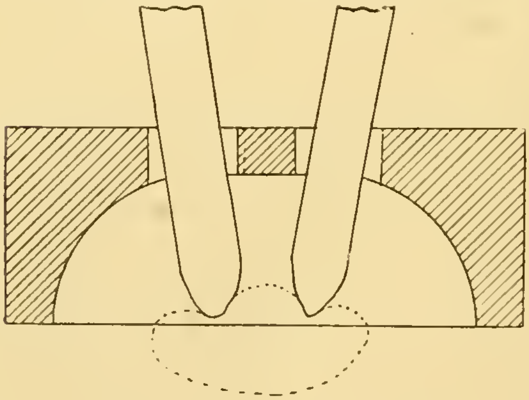

FIG. 1.—Arrangement of Carbons in Flame Arc.

Flame carbons are constructed to burn with the carbons arranged vertically above one another, as in ordinary lamps, but the more general construction is to arrange the carbons side by side inclined to one another at an angle of about 15°, as shown in Fig. 1. The arc, which balances between the tips of the carbons, as shown in the figure, is spread out into a fan shape, and kept down at the tips by the use of a magnetic controlling field. Immediately above the arc, both in the lamps for vertical and inclined carbons, is placed an inverted cup, the object of which is to prevent the free upward currents of air and maintain the carbons always in an atmosphere of inert gases, thus considerably lengthening their burning hours. This cup is consequently given the name of an economiser.

The arrangement of the carbons in the inclined lamps causes a very large proportion of the light to be thrown vertically downwards, which is certainly not a desirable condition for the lighting of open spaces, involving as it does hanging the lamps very high if even illumination is to be obtained. The rich golden-yellow colour of the light though useful for the purpose of display, is also to be reckoned as a disadvantage of these lamps. The colour is, however, not so very far different from that given by the incandescent lamp, and has not been found a very serious drawback. Flame arcs of other colours, for example, white and pink, can be produced, but the volume of light in these cases is greatly below that of the yellow arc. The flame arc lamp has an efficiency of approximately 0·4–0·5 watt per mean spherical candle, which is two or three times as good as that of the ordinary open-type arc. The high cost of maintenance in carbons, which are expensive to make and burn rapidly, is very much more than compensated by the low cost of power for a given amount of light. In the Blondel lamp the carbons which are used are of larger diameters, and are arranged vertically one above the other. This has the advantage of giving a better light distribution, and it is claimed that the mean spherical candle-power is nearly double that of the ordinary flame arc.

Whilst the flame arc has been rapidly developed in Europe, it has met with but little success in America on account of the fact that in America the cost of labour for frequent trimming counts much more than it does in this country. For this reason the use of enclosed arcs in America has become almost universal in spite of the fact that they only have about half the efficiency of the ordinary open arc. To meet these somewhat special conditions, experimental work has been carried on during the past two or three years by Messrs. Steinmetz and the General Electric Company of America on the production of a long burning flame lamp. The "magnetite" arc, as it is called, which is the result of this work, utilises electrodes composed chiefly of magnetic oxide of iron. In the latest electrodes titanium oxide, which produces a more intense light in the arc than iron oxide, is used, but iron oxide is still employed to give the electrode conductivity when cold. The actual mixture contains also oxide of chromium, but this plays a purely secondary part in steadying the rate at which the other oxides are evaporated.

The lamp is constructed with the magnetite electrode as the negative, and a solid copper electrode as the positive. In place of copper a special alloy is being introduced. The arc has all the characteristics of a flame arc, but possesses some peculiarities due to the fact that the flame-producing material is contained only in the negative electrode. Its efficiency, from figures which have been published, appears to be in the neighbourhood of 0·8 to 1·0 watt per candle, from which it will be seen that it is a little more efficient than the ordinary open-type arc and twice as efficient as the ordinary enclosed arc, which will be its greatest competitor in America. The electrodes, when 12 inches long, are stated to have a life of 150 hours, which is as much or more than similar sized electrodes in enclosed lamps. It will therefore be seen that the magnetite arc is likely to prove a valuable advance on the enclosed arc, and where economical conditions have determined the use of this lamp it is likely to be superseded by the magnetite arc. It cannot, however, at present compete against the ordinary flame lamp, where the cost of trimming is not so important a factor.

*Vapour Lamps.*

A word may be said in relation to the development of the mercury vapour lamp. This type of lamp, which has been developed by Mr. Cooper-Hewitt in America, has not met with any extended use on account of the exceedingly unpleasant colour of the light which it gives. Though in some circumstances this may not prevent the adoption of this lamp, there is no doubt that it will always seriously hamper its use in competition with pleasanter coloured illuminants. Attempts have been made to improve the colour by introducing other metals, such as metals of the alkali group, into the tube, but these have not hitherto proved successful. It is stated, however, that a very marked improvement has been effected by the firm of Heraeus, in Germany, by adopting quartz tubes instead of glass tubes, and pushing the temperature at which the arc is run up to very much higher limits. By working the lamp at such a current density that the internal pressure in the tube is approximately one atmosphere, it is stated that the efficiency of the lamp is more than doubled, and that a continuous spectrum is added to the line spectrum of the mercury, thus giving the light a quite pleasant and almost normal colour. These quartz-tube lamps have the additional advantage that under the conditions of working the length of tube for a given voltage is very much less than when glass tubes are used. The commercial introduction of these lamps is promised for this year.

Reference might also be made to one other type of electric lamp which has during the past year come into commercial use, namely, the Moore tube lamp. This lamp is simply an ordinary vacuum tube of great length, and operated at a very high voltage. The tubes, which are $1\frac{3}{4}$ inches diameter, can be made up to 200 feet in length, and are fixed up in position by welding together short lengths of tube, high-voltage supply being obtained by means of a transformer the secondary terminals of which are connected to graphite electrodes in the tube. The essential feature of this lamp is the method which has been adopted to overcome the difficulty that the vacuum decreases as the lamp burns, owing to the absorption of gas by the glass tube. In order to maintain the vacuum constant a most ingenious valve is employed. The main tube communicates by means of a branch with the outer air, this branch tube being sealed by a porous carbon plug covered with mercury. The level of the mercury can be altered by the rising or falling of a float; in one position of the float the carbon plug is completely covered, in the other it is partly uncovered. The movements of the float are controlled by a solenoid connected in series with the primary of the transformer supplying the tube. When the vacuum falls the conductivity of the tube increases and the primary transformer current rises; this lifts the mercury float and causes the mercury level to fall, uncovering the point of the carbon plug and allowing a little air to filter into the tube. The conductivity of the tube is thereby decreased, the primary current falls again, and the porous plug is again completely covered with mercury. It is stated that this valve, which operates normally about once a minute, maintains the vacuum in the tube, which is in the neighbourhood of 0·1 mm. of mercury, constant within 10 per cent.

The only installation of this lamp in this country is that in the courtyard of the Savoy Hotel, and those who have seen this will probably agree that the light represents in many respects the ideal form of artificial lighting. The colour of the light given by the tube depends upon the gas which it contains, and is pure white for carbon dioxide, slightly pink for nitrogen or air. Nitrogen is stated to be twice as efficient as carbon dioxide, and slightly more efficient than air. When it is desired to operate the tube with either of these gases the open end of the valve is connected to either a phosphorus tube (to extract the oxygen from the air drawn in) or to a gas apparatus generating carbon dioxide by the action of acid on marble. The efficiency of these lamps is difficult to determine, but appears to be in the neighbourhood of 1·6 to 1·8 watts per candle.

It is interesting to note that the improvements described above in incandescent and arc lamps have once again brought electric lighting on practically the same level for cheapness as gas lighting. The introduction of the gas mantle gave gas lighting so great a superiority on the score of cheapness that for a great many years it has only been possible for electricity to hold its own on account of its many other advantages. Just as the ordinary gas mantle beat the carbon filament lamp, the high-pressure gas-mantle systems competed on an equal, or even on a slightly better, basis with arc lighting. The whole complexion which appears is now changed, since the 1 to 1·5 watt metal filament lamps can compete with the ordinary mantle for small lighting, and flame lamps are superior to the high-pressure gas lamps. It must be remembered that, from a scientific point of view, the efficiency of electric lamps is vastly superior to any type of gas lamp, the main cheapness of gas lighting being entirely due to the difference between the cost of power delivered to the lamp in the form of gas and in the form of electric energy. It is interesting to remark that whereas the improvements in gas lighting have been effected by departing from an incandescent flame to an incandescent solid, the improvements in arc lighting have been obtained by a move in exactly the opposite direction.

In conclusion, attention may be directed to the honourable position occupied by this country in the developments of electric lamps. A little more than a century ago an English philosopher, Sir Humphry Davy, discovered the electric arc. Thirty years ago an English inventor, Sir Joseph Swan, shared with an American, Edison, the distinction of overcoming the difficulties attendant upon the production of an incandescent electric lamp of small candle-power. With these two names England's connection with the development of electric lighting begins and ends. The first satisfactory arc-lamp carbons were made by Carré (France). The invention of the cored carbon is due to Siemens (Germany), the practical realisation of flame carbons to Bremer (Germany), and their further development to the Continental manufacturers and to Blondel (France). The magnetite arc has been developed by Steinmetz and the General Electric Company of America. The mercury arc was shown to be practical by Arons (Germany), and was perfected by Cooper-Hewitt (America). Its latest development is due to the firm of Heraeus (Germany). The vacuum-tube lamp we owe to McFarlane-Moore (America). In incandescent lighting the only radical improvement which has been effected in the carbon filament is the metallised filament of the General Electric Company of America. The Nernst lamp is due to Prof. Nernst and the A.E.G. of Germany. The first metal filament lamp was the "Osmin" lamp of Welsbach (Germany), which was followed by the tantalum lamps of Siemens (Germany) and the tungsten lamps which were perfected by Welsbach (Germany), Just and Hannaman (Austria), and Kuzel (Austria).

One may well ask what is the reason for this unsatisfactory state of affairs. The actual reason is not far to seek. In the field of scientific discovery England has always been, and still is, in the front rank, but not any of the improvements enumerated above are in the nature of discoveries, but are all inventions of a type which have been, and can only be, developed by years of costly experiments carried out always with a commercial end in view, a form of research which is for the most part carried out in the laboratories which are to be found attached to the more important Continental and American factories. The question therefore reduces to asking why it is that these laboratories are not to be found in connection with English works. If you ask the manufacturer, he will probably answer that with unprotected markets, unrestricted competition, and the uncertainty of being allowed to enjoy the fruits of his labour, he cannot afford to spend a share of his money in the prosecution of costly research which may only after many years, and possibly never, yield results. If you ask the man of science, he will probably tell you that it is due to the complicated set of facts which were summed up by Prof. Perry in the words "England's neglect of science," of which the most striking examples are afforded by the position which science takes in all our systems of education, and by the attitude of indifference, amounting almost to contempt, which is directed towards it by all our Governments, our men of means, our manufacturers, and almost all classes of the community. Each answer probably comprises part of the truth, and the two together possibly comprise the whole, and whilst everyone is agreed that something ought to be done, we are all too busy arguing which is the best specific to take any steps towards a remedy. In the meantime, further developments are being worked out abroad, and every year is making it harder for this country to make up the leeway which it has lost and is losing.

Maurice Solomon.

## RUSSIAN SCIENTIFIC WORKS.

THREE volumes of the Bulletin of the Academy of Sciences, containing the proceedings of the physico-mathematical section, have been received recently. In vol. xxii. Mr. Wyragevitch describes certain Actinozoa of the Black Sea in the neighbourhood of Balaclava, and Mr. A. Borissiak contributes notes on the Black Sea plankton. Mr. K. N. Davidoff's article on the islands of the Indo-Australian archipelago deserves mention. The confusion of European and Malay races in Amboina has produced a curious type, and the Malay tongue has absorbed, it is shown, Dutch and Portuguese words. The barbarous custom of wooing with the head of an enemy still prevails. The Solifugæ of Persia are discussed by Mr. A. Birula. In vol. xxiii. Mr. V. Bianchi writes on Passeriformes and Palæarctic larks, basing his remarks on studies in the museums of London, Tring, and Paris. Mr. N. Donitch contributes observations of the annular solar eclipse in March, 1904, made at Cambogia, and of the total solar eclipse in August, 1905. The latter was observed from Alcala and Assouan. Notes on inundations at St. Petersburg are contributed by Mr. S. Griboyedoff, and studies of rainfall in that capital, with diagrams and tables, are given by Mr. E. Rosenthal. Vol. xxiv. contains the results of lengthy investigations, by Mr. A. Bielopolsky, of the radial velocity of the variable star Algol, and another astronomical paper, by Mme. Zhiloff, on the orbit of the minor planet Doris (48). A new species of pheasant from the mountain regions of western China is described by Mr. V. Bianchi. Details of balloon experiments at the aërodynamic institute at Kutshino are furnished by Mr. V. Kuznetsoff. From fossils collected by the Polar expedition of the late Baron Toll in 1900–3, Mme. M. Pavloff is able to draw deductions as to the changes of climate in east Siberia since the Tertiary period. Several papers on aërial mechanics are contributed by Mr. D. P. Riabushinsky. Mr. M. Golenkin writes on a botanical visit to Java, and the report of the geological museum of Peter the Great concludes the volume.

In series vi., part i., of the Bulletin of the Imperial Academy of Sciences, Prince B. Galitzin describes the seismic station at Pulkovo. Mr. P. Vannari writes on the duration of sunshine in Russia. Part ii. opens with suggestions, by Mr. M. A. Nikatshev, for the establishment of a commission to arrange atmospheric observations in different parts of Russia. A memoir of Prof. D. I. Mendeléeff appears in part iii. Memoirs of the geologist N. A. Sokoloff, the chemist H. Moissan, the German meteorologist W. von Bezold, and Signor G. I. Ascoli, philologist, appear in part iv. Among short abstracts of papers is one by Mr. A. Kuljabko on the application of artificial circulation to heads of fishes after cutting them off, and one by Mr. V. Bianchi on Muscicapidæ. In a note on the temperature of lakes, Mr. V. B. Shostakovitch confirms the opinion of Middendorf that a mass of water heated in summer will retain this heat for a long time in spite of heavy frost and snow on the surface. Part v. contains memoirs of the geologist Bertrand and the chemist Berthelot. Mr. A. S. Skorikoff has made elaborate investigations of the plankton of the Taurida pond, St. Petersburg. Mr. S. P. Popoff has studied crystalline phosphates from the shores of the Gulf of Kertch. Prince B. Galitzin writes in part vi. on lines in the spectrum of mercury vapour. Mr. N. Korostelev reports on actinometrical observations at Tashkent in February of last year. Of geological interest are the papers by Mr. A. Fersmann on stolpenite from the Rhone and pyrargyrite from the Pervoblagodatsk ore in the Urals. In part vii. Mr. V. Bianchi describes forms of Pyrrhospiza.

Papers by Mr. A. Karpinsky on the results of soundings in the Pripet basin, and by Mr. A. Fersmann on the mineralogy of the Simferopol district, will be found in part ix. In part x. Mr. F. N. Tshernisheff writes on the discovery of Upper Trias in the northern Caucasus, based on the researches of Mr. V. I. Vorobieff. Mr. Y. S. Edelstein writes on the discovery of Upper Silurian layers in the neighbourhood of Samarkand. The longest paper is that of Mr. V. I. Vernadsky, on striation in crystalline surfaces, with mathematical illustrations. In No. 11 brief notices are given of papers on different investigations, which are to appear *in extenso* either in the Annals of the Zoological Museum or the Transactions of the Academy. One of the most interesting of these is the abstract of Mr. L. S. Berg's paper on the fish of the Amur basin, where the fish consist of a mixture of Palæarctic and tropical forms. Two articles are devoted to crystallography; Mr. V. V. Karandeieff writes on rotatory power and symmetry, and Mr. V. I. Vernadsky discusses the physical theory of twin formation and crystalline groups. Some critical forms of Centaurea, L., are described by Mr. A. Petunnikoff. A controversial article, "In Defence of Natural Genera," written in English, is contributed by Mr. V. Bianchi, who differs from Dr. E. Hartert over what he calls "genus-lumping."

In No. 12 Mr. V. Lubimenko gives a paper on the influence of light on the absorption of organic substances by green plants. Investigations were directed to (i) has light any influence on the assimilation of organic combinations, where photo-synthesis is entirely absent? (ii) what is the influence of light of different intensities? (iii) is the influence of light dependent on the absorption of different wave-lengths? Experiments connected with light and the absorption of saccharose, glucose, and maltose are described, and Mr. Lubimenko hints that further experiment will provide interesting results. Mr. P. K. Kokovtsov's paper on some Central Asian tombstone inscriptions of Syrian-Christian character belongs to literary archæology. Astronomers will be interested in the calculations (in French) of the elements of Encke's comet, by Mr. Kamensky and Mdlle. E. Korolikov. There are short communications by Mr. O. Backlund upon the rhombic pyroxene of a hypersthenic gneiss, and by Mr. P. Stepanov on the Upper Silurian fauna of the Lake Balkhash district. Prof. G. D. Romanovsky studied the palæontological materials of Turkestan gathered by different investigators, and sedimentary formations belonging to all periods from the Silurian, with the exception of the Permian period, have been identified in that province.

Much research is recorded in vol. iii. of Mr. G. E. Grum-Grzhimailo's description of a journey in western China, round Kuku-nor, through Nan-shan, Bei-shan, and along eastern Tian-shan to Russia. There are handsome maps of Nan-shan, Bei-shan, and Tian-shan, showing the route of the expedition, twenty-five phototypes, and twenty-nine zincographs. The earlier chapters describe the route and adventures; the later chapters and appendices deal with natural history. The women of the Panaks (Kuku-nor Tanguts), who are in a position of humility, maintain an immemorial custom of veiling their faces in their plaited hair before strangers. There are two chapters on the ethnology of Amdo and the Kuku-nor region, the native names of localities being given with explanations and comparisons. One conclusion is that there is a strong white admixture among the Tibetans, who have a legend that their first king came from India. Butterflies (*e.g. Agrotis xanthographa*, F., and *Pseudohadena pexa*) approached the encampment when the temperature was surprisingly low. The Mongols and Tibetans consider the bear as king of beasts, and in the nature of a missing link between man and beast. It is thought that tales of "dumb, hairy savages" may sometimes be traced to inexperienced travellers who have seen bears. A rock was seen bearing an inscription in Mongolian and Tibetan, the Buddhist prayer "Hail, Pearl hidden in the Lotus," probably referring to *nirvana*, the translation and interpretation of which are a mystery. There are explanatory notes by Gabet and Waddell. Two legends with regard to the origin of kite-flying among the Chinese are recorded. When the expedition refused the offer of a convoy, the Chinese commander remarked, "Your men are a hundred times braver than our soldiers." A chapter is devoted to the climate of Tibet. Extensive study of the fauna shows that many examples of Siberian forms occur in Tian-shan, Han-su, and Pamir fauna, and our author traces the probable route of these forms by way of the Caucasus and Hindu-kush. As regards Lepidoptera, the interior regions of Tibet are a *terra incognita*. Several pages are occupied with the distribution and classification of Parnassius and Colias. The wanderings of the Old Believers, mentioned by Prjevalsky and Kozlow, are the subject of a separate chapter.

A rich and interesting ornithological collection of 1500 skins, twenty-two eggs, five nests, and three skeletons, made by Mr. Kozlow, has been entrusted to the experienced hands of Mr. V. Bianchi, and its description is contained in "Mongolia and Cham," vol. v., "Aves expeditionis Kozlowi." Eight new endemic forms were discovered. The name Cham or Kham relates broadly to the whole Alpine country of south-eastern Tibet, and in a narrower sense it refers to the area upon which agriculture is possible at a certain height. In the latter sense the boundaries of Cham are still uncertain. The volume opens with a physicogeographical sketch of the regions traversed by the expedition, passing to tables of distribution and analyses of the different species. The chief interest of the collection is that it was made in localities previously unvisited by European naturalists. Four plates of birds appear at the end, with a map indicating the routes of Mr. Kozlow and his colleagues. The longitude is reckoned from Pulkova, 50°–80°, the difference of longitude between Greenwich and Pulkova being 30° 19′ 40″·10. The classification of diatoms was entrusted to Mr. K. S. Merezhkovsky, and Mr. N. A. Tatshaloff recorded the astronomical results of this important expedition, their work being contained in two shorter volumes.

## THE AMERICAN PHILOSOPHICAL SOCIETY.

THE general meeting of the American Philosophical Society was held at Philadelphia on April 23–25. The opening session was on April 23, and morning and afternoon sessions were held on the following days, with an evening lecture by Prof. H. F. Osborn on April 24 at the hall of the Historical Society of Pennsylvania, which was followed by a reception to the visiting members and friends of the society. The sessions were largely attended. The meeting closed with a dinner at the Bellevue-Stratford on the evening of April 25.

Forty-two papers were presented, covering a wide range of subjects, but we are only able to find space for summaries of a few of them.

"Determination of Dominance in Mendelian Inheritance," Dr. C. B. Davenport. In studying heredity, where a single character is considered which one parent possesses and the other lacks, or a character that is contrasted in the parents, it is generally found that the offspring are alike, and like one parent only. From examples of poultry, of insects, of certain mammals, including man, and certain plants, in regard to inheritance that may be described as Mendelian, it is concluded that where a stronger determiner meets a weaker determiner in the germ, dominance is the result. When the character is present in one parent only we have the extreme case and typical Mendelian inheritance, but when the determiners are of nearly equal potency the Mendelian law is obscured.

"A Preliminary Report upon a Crystallographic Study of Hæmoglobins: a Contribution to the Specificity of Vital Substances in Different Vertebrates," Profs. E. T. Reichert and A. P. Brown. The primary object of this research was to determine whether or not corresponding albuminous substances are identical in different species. The results of the investigation, which has covered more than one hundred species of vertebrates, show:—(a) the crystals of oxyhæmoglobin obtained from any single genus are isomorphous, but unlike those obtained from other genera unless these genera are closely related or in the same family; (b) specific differences in angle and habit are obtained between crystals obtained from species of the same genus, so that it is generally possible to re-organise the species by the crystals; (c) the occurrence of several types of crystals of oxyhæmoglobin in the same species; (d) indications are found in the crystal angles of a substance in the molecule common to all hæmoglobins, no matter what the system of crystallisation. The application of this method of research to problems in zoological classification and in heredity was pointed out.

"The Effect of Certain Preservatives upon Metabolism," Dr. H. W. Wiley. Details were given of the work that Dr. Wiley is carrying on in the study of the effect upon the human organism of a number of preservatives commonly used in the preparation of foods, such as borax, boric acid, salicylic acid and salicylates, sulphurous acid, sulphites, benzoic acid and benzoates, formaldehyde, copper sulphate, and potassium nitrate. Experiments with the first five of these preservatives show conclusively that their continued use, in quantities such as are used in food preservatives, hinders or prevents metabolism, and may seriously derange the functions of the organism. The other substances enumerated are still under investigation, but the results thus far obtained seem to indicate that they are equally injurious.

"Observations Regarding the Infliction of the Death Penalty by Electricity," Prof. E. A. Spitzka. This paper sets forth the history of "electrocution," the methods employed, and the phenomena observed in this mode of death, together with the *post mortem* findings, detailing the observations of the author, based upon thirty-one electrocutions at Sing Sing, Auburn, Dannemora, and Trenton prisons. Compared with other methods, "electrocution" is the most humane method of inflicting the death penalty, because of its efficiency, quickness, and painlessness, and it should be adopted in every State in the Union.

"A Comparison of the Albino Rat with Man in Respect to the Growth of the Brain and the Spinal Cord," Prof. H. H. Donaldson. A statistical study of the growth of the brain and the spinal cord in the white rat, in which the weight of the brain and of the spinal cord is recorded and compared with the body weight at various stages of the development of the animal. The results are plotted, and from these records logarithmic curves are drawn. When compared with the curves derived from the same data in the case of man, and plotted to a corresponding scale, a close similarity in the curves is noted.

"The Classification of the Cetacea," Dr. F. W. True. The opinion is expressed that the Cetacea are not directly derived from Zeuglodonts, and that their origin is not at present known; also that the white whale and the narwhal should not be removed from the family Delphinidæ, and that the river dolphin, Stenodelphis, should, for the present at least, be placed in that family.

"Results of the American Museum Exploration in the Fayûm Desert of Northern Egypt," Prof. H. F. Osborn. The camp of the American Museum Expedition was located to the west of Qasr el Sagra, near the bone quarries opened by Beadnell. Remains of Arsinoïtherium, Palæomastodon, and Mœritherium were obtained from these quarries. A reconnaissance into the Zeuglodon valley, near Gar el Gehannem, was described. The restorations of Mœritherium and Palæomastodon, made by Mr. Charles R. Knight under the direction of Prof. Osborn, were exhibited. From northern Africa the elephant stock migrated south through Africa, north into Europe, and north-east and east through Asia into the Americas. From a comparison of the ancestral elephant Mœritherium with the Sirenian Eotherium, it is believed that the sea-cows and elephants are derived from the same stock.

"Additional Notes on the Santa Cruz Typotheria," Dr. W. J. Sinclair. A presentation of the general conclusions reached as a result of two years' study of the Typotheria from the Santa Cruz formation of Patagonia. They appear first in the Notostylops beds (uppermost Cretaceous or basal Eocene), and become extinct in the Pampean (Pleistocene). It is generally assumed that the rodents and conies are related to Typotheria, but this does not appear to be the case; the resemblances are probably due to convergence. The Toxodontia and the Typotheria probably had a common origin. The Typotheria do not lend much support to the idea of a former land connection with Africa, showing no relationship with the recently discovered Eocene mammals from the Fayum province of Egypt.

"Progress in the Demarcation of the Boundary between Alaska and Canada," Prof. O. H. Tittmann. Details are given of the methods employed in determining the Alaskan boundary. The length of the boundary is about twelve hundred miles, extending from the Arctic Ocean south along the 141st meridian to near Mt. St. Elias, and thence along the coast strip of south-eastern Alaska. In south-eastern Alaska aluminium-bronze monuments are placed wherever it is practicable to do so, but, as most of the turning points in the line are inaccessible snow-clad peaks, they will be defined by triangulation connection with the work of the Coast and Geodetic Survey. The initial point on the 141st meridian, which is also being marked by monuments, was determined by a telegraphic longitude circuit extending overland from Vancouver through Canadian territory, and by way of Seattle and the United States Government cables to Valdez, and thence overland to the boundary.

"A Living Representative of the most Primitive Ancestors of the Plant Kingdom," Dr. G. T. Moore. Chodat has derived the green algæ from the Palmellaceæ. In this family he points out that there exist three principal stages or conditions:—(1) the zoospore condition; (2) the sporangium condition; and (3) the tetraspora condition. The author thinks that a better starting point is found in Chlamydomonas, which also shows three corresponding conditions in addition to the zoospore type, namely, the volvex type, the tetraspora type, and the endosphæra type. The tetraspora type of Chlamydomonas has developed into the Palmellaceæ, and thence into the algæ and higher green plants. Even as high as the mosses and ferns a Chlamydomonas stage is to be seen in the male gamete.

"The Explosion of the Saratoga Septic Tank," W. P. Mason. The explosion of a tank used for the storage of sewage, and supposed to be due to the ignition of an explosive mixture of marsh gas and air, is discussed. The marsh gas is derived from the fermentation of the sewage, and the ignition is assigned to the generation of phosphine, which is supposed to have ignited spontaneously.

"Some Chilean Copper Minerals," Prof. H. F. Keller. The author describes a number of rare minerals containing copper from the mines in the province of Tarapaca, Chile. Among them the most interesting are peloconite, a manganese ore containing a considerable proportion of copper; a new double sulphate of copper and magnesium isomorphous with chalcanthite; and a beautifully crystallised sulphate and arsenate of copper, which could not be identified with known species.

"Absorption Spectra of Solutions," Prof. H. C. Jones. The object of the present investigation was to ascertain whether combinations between the solvent and dissolved substance had any effect upon its power to absorb light. Certain salts in the anhydrous state have very different absorption than when combined with water. A solution of anhydrous neodymium chloride in absolute alcohol gives absorption bands differing from those obtained when a few per cent. of water is added. The application of this observation to the author's theory of hydration is discussed.

"Effect of an Angle in a Wire Conductor on Spark Discharge," Prof. F. E. Nipher. The problem to be solved is to determine the real current direction in a wire through which a spark discharge is passing. The spark discharge was that of a long eight-plate machine. One terminal was grounded on a water pipe, the other was grounded in the air. A small wire bent at a sharp right-angle was placed vertically in the lines of the earth's magnetic field, and so connected that the negative discharge could be sent either up or down around the angle, and its effect recorded on a photographic plate placed under the angle. Very interesting photographic results were obtained, but the author does not consider that the main question was conclusively answered.

"Some Results of the Ocean Magnetic Work of the Carnegie Institution of Washington," Dr. L. A. Bauer. Dr. Bauer described the work of the *Galilee* expedition in the Pacific since August, 1905. The work accomplished, briefly stated, is as follows:—(*a*) magnetic observations have been made on the ocean areas which closely approach land observations in accuracy; (*b*) errors found in magnetic charts of the Pacific Ocean amount to 1° to 5° in declination (or variation of the compass) and in dip, and about 0·04 in the horizontal magnetic force. The correction of such errors, especially the error in declination, is of great importance for the safe and rapid navigation of vessels.

"The Investigation of the Personal Error in Double-star Measures which Depend on the Position of the Angle," Eric Doolittle. This paper gives the result of the determination of the constant personal errors, and also of the probable uncertainty of the measures of double stars made during the past ten years at the Flower Astronomical Observatory of the University of Pennsylvania.

"Relative Advantages of Various Forms of Telescopes for Solar Research," Prof. G. E. Hale. Prof. Hale discussed different types of telescopes for solar research, describing particularly the equipment at the solar observatory of the Carnegie Institution at Mount Wilson, California. The advantages of the fixed horizontal telescope with heliostat were pointed out. The author also described the large spectroheliograph of this observatory, and exhibited a number of examples of photographs taken by means of this instrument, including solar prominences, faculæ, and sun-spots.

"Photographs of Daniel's Comet," Prof. E. C. Barnard. The comet was photographed on thirty-eight nights with the Bruce photographic telescope of the Yerkes Observatory. The photographs showed that the most active period in the comet's history occurred nearly a month before perihelion, at which time changes occurred so rapidly that the appearance of the comet changed from night to night. Indeed, on comparing the Yerkes Observatory photographs with photographs made at M. Flammarion's observatory in France and at the Lick Observatory on the same night, marked differences in the photographs could be seen.

## *SOME RECENT AGRICULTURAL PUBLICATIONS.*[1]

(1) A CONSIDERABLE change has come over the Journal of the Royal Agricultural Society during the last few years. Founded in 1839, its earlier numbers contained many papers of great scientific and practical interest, and the student of agricultural science frequently has occasion to refer back to them for the writings of Daubeny, Pusey, Way, Lawes and Gilbert, A. Voelcker, and others of the great masters who contributed some of their best work to its pages. It cannot be said that recent numbers are up to the high standard of the older ones. Several causes have contributed to bring about this result. The journal only appears once a year, and men are often unwilling to hold back their papers from publication for so long a period. Much of the work done at the various colleges is directly or indirectly financed by county councils, who like to see something for their money; the results are therefore issued as separate bulletins by the councils or colleges concerned, and distributed among the farming community. Recently, too, some very vigorous competitors, including the Journal of the Board of Agriculture and the Journal of Agricultural Science, have arisen, and these publish much of what would, in the past, have found its way to the Royal Agricultural Society's Journal. The present volume is smaller in size even than the first one issued nearly seventy years ago! There has been a considerable change in the character of the papers. The original paper has almost disappeared; there is, for instance, in this volume not a single contribution from the various teaching centres, if we exclude the report of the zoologist and Mr. Archibald's notes on certain birds, while Rothamsted only contributes a short note. Instead, the papers are of a "practical" or a text-book nature; they describe accepted good practice on certain matters, or give information which could be found elsewhere if the reader knew where to look for it. There is much to be said for this, and the utility of some of the papers in the present volume is beyond question, but it is doubtful whether this is quite the best line to take up. The journal would almost certainly be more valuable to the practical man if it aimed at furnishing him with a record of the progress of agricultural knowledge in its various branches so that he could apply the newly discovered facts to his own methods, if he thought he would gain thereby, and be in possession of definitely established principles to guide him whenever it became necessary profoundly to modify his practice, as happened to many of the wheat-growers a generation ago, and is happening to the hop-growers now. Such a record would include a critical survey of the numerous county council feeding and

[1] (1) The Journal of the Royal Agricultural Society of England, vol. lxviii. (1907.)
(2) Bulletins 1 to 8 of the Midland Agricultural and Dairy College (Field trials in 1907).
(3) Results of Experiments at the College Farm, 1907, University College, Reading.
(4) Bulletin No. 7 Armstrong College, Newcastle-upon-Tyne.
(5) Field Experiments in Staffordshire and Shropshire for 1907.

manurial trials, of progress in soil management, plant breeding, in bacteriology, in our knowledge of plant and animal requirements, so far as practical agriculture is concerned, besides dealing with questions of cost and with practical methods ascertained to give good results and worthy of wider trial.

To come, however, to the actual papers. Two on pigs deal respectively with the general problem and with the bacon-curer's requirements in a way that will appeal to the practical man. Mr. Archibald completes a series of notes on wild birds begun in the journal for 1892 and continued in the 1894 number; if these could be bound up into a separate booklet they would doubtless prove very attractive to the agricultural community. The report on the prize farms in Lincoln is a valuable revival of a practice discontinued since 1892; some of the best things in the literature of practical agriculture are found in the old reports. Mr. Güssow's article on poisonous plants is of interest both to botanists and to practical men.

Dr. Voelcker's report on the work carried out at Woburn is as interesting and suggestive as usual. In the pot-culture station, lithium salts have been found to be very poisonous to wheat, as little as 0·05 per cent. reducing the yield to one-quarter, whilst manganese and iron salts increased the yield. A connected account of the work is promised, and will be awaited with interest. In the field experiments it has been thought desirable to alter the scheme of manuring consistently adhered to since 1876, and we cannot help thinking that this is a great mistake. Stackyard field is one of the best experimental fields in the kingdom, and would prove an almost ideal place for solving problems in soil physics and in soil bacteriology when the methods of working are sufficiently developed. Manures take so long to act on the soil, and we know so little about the action, that it would surely have been better not to break the continuity of treatment, but to leave the fields as material for future workers just as is being done at Rothamsted.

(2) to (5) These bulletins are typical of much of the work executed under the auspices of county councils. The field trials fall under two heads, variety and manurial trials; in the former a number of the varieties of a plant are grown to see which gives the biggest yield, in the latter a scheme of manuring is designed to test the effect of the various fertilisers. Properly executed with duplicate plots and accompanied by adequate chemical analyses, the manurial trials are capable of furnishing results both of practical and scientific interest. Without soil analyses the results have only a temporary value, and are, indeed, often useless to those who do not know the actual field on which the trial was made. Although no analyses are recorded in the bulletins, it is to be hoped they exist. The Midland College bulletins speak well for the energy and enterprise of the staff. Some refreshing departures from the conventional *motif* are found in the Reading report, the experiments on weeding and on cultivation being particularly interesting. E. J. R.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The Public Orator, Dr. Sandys, spoke as follows in presenting to the Chancellor the five representatives of mathematics and natural science who received the degree of Doctor in Science *honoris causa* on June 17:—

The Hon. Charles Algernon Parsons, C.B., F.R.S., Honorary Fellow of St. John's.

Regiae Societatis praesidis, Astronomiae fautoris maximi filius, quem hodie decoramus, etiam in ipsa pueritia machinarum novarum inventor felix fuisse dicitur. Postea Dominae Margaretae Collegii alterius scholaribus adscriptus, honorum mathematicorum in classe prima, Dominae Margaretae in nave prima, locum insignem est adeptus. Deinde Archimedis aemulis hodiernis additus, non grammophoni tantum tubam terribilem sonitus suaviores edere docuit, sed etiam navium vi vaporis impulsarum more novo movendarum opus difficillimum exitu prospero est aggressus. Machinae genus illud novum, a Societate Regia numismatis aurei honore approbatum, etiam navibus maximis oceanum transeuntibus postea est accommodatum. Quod si Neptunum ipsum alumni nostri de meritis interrogare volueritis, sine dubio Neptunus ipse protinus respondebit:—

Experto credite quantus
Per pontum properet, quo turbine torqueat undas.

Sir Andrew Noble, Bart., K.C.B., F.R.S.

Ballistarum scientiam hodiernam baronetti huius ingenio plurimum debere inter omnes constat. Milites nostri, machinarum bellicarum in apparatu neque terra neque mari rerum novarum cupidi, viri huius praesertim consiliis admoniti, meliora didicerunt. In ballistis vero nostris in melius mutandis, atque etiam imperii Iaponici in navibus aedificandis, nemo Archimede nostro venerabili plus effecit. Nemo operariis nostris cessantibus et mercedem maiorem flagitantibus potiora suasit. Quid autem est praeclarius quam honoribus perfunctum senem posse dicere idem quod apud Ennium dicat ille Pythius Apollo, se esse eum unde sibi et populi et reges et omnes sui cives, summarum rerum incerti, consilium expetant?[1]

Sir William Crookes, F.R.S.

Cancellarii nostri auspiciis nunc demum eum ipsum praesentem videmus quem diu desideravimus, quem alia ex alia scientiarum in studiis occupata Societas praesidem suum olim suspexit. De scientia chemica et physica explorenda per annos plus quam quinquaginta praeclare meritus, in rerum primordiis primis spectri (ut aiunt) auxilio examinandis eam ipsam provinciam feliciter exploravit, quae etiam scientiae physicae in officina nostra maximo cum fructu indagata est. In observando quam acutus est, in experiendo quam peritus, in rebus difficillimis investigandis quam pertinax! Viri tanti exemplo Vergili dictum denuo praeclare confirmatum est:—"Labor omnia vicit improbus."

Prof. Horace Lamb, F.R.S., Late Fellow of Trinity, Professor of Mathematics in the Victoria University, Manchester.

Abhinc annos septem et triginta Newtoni in Collegio alumnum nostrum Newtoni disciplinam perquam feliciter coluisse constat. Postea in Australia professor nominatus, in colonia nostra remotissima studiorum mathematicorum, studiorum physicorum, diu duratura posuit fundamenta. Deinde scriptorum eius propter merita insignia a Mancuniensibus domum revocatus, ea quae ipse de vi electrica disputationum suarum in regione pura invenerat, ab aliis in machinis fabricandis vita nova donata vidit. Peritis nota sunt "Hydrodynamica" eius, in editione nova in maius exaucta. Etiam aliis innotuit oratio Societatis Britannicae in conventu Cantabrigiensi haud ita pridem pronuntiata, in qua primum studiorum mathematicorum historiam recentiorem dilucide delineavit; deinde etiam in studiis illis severis aliquid audendum, aliquid periclitandum esse dixit; denique rerum naturam nondum omnem esse exhaustam, sed miraculis etiam nunc esse plenam, quae scientiarum cultores per plurima in posterum saecula sint exercitura.

Prof. George Downing Liveing, F.R.S., Fellow of St. John's.

Abhinc annos duo et sexaginta Cantabrigiam primum petivit vir intra proximum quinquennium in disciplina mathematica et in rerum naturae studiis honores summos adeptus, qui, post itinera sua Berolinensia, scientiae chemicae inter nosmet ipsos docendae sese strenue dedicavit, et Divi Ioannis in Collegio primam scientiae illius officinam Cantabrigiensem aedificandam curavit. Postea Universitatis professor nominatus, horum studiorum officinae amplissimae publice condendae summam diligentiam, summam operum exterorum experientiam, feliciter adhibuit. Lucis vero radiis spectri (ut aiunt) ope retexendis, et rerum naturae penetralibus examinandis, quot annorum labores dedicavit! quot discipulis studiorum uno tenore assidue peractorum exemplar quam pulchrum praebuit! In operibus bonis adiuvandis liberalissimus, in negotiis academicis partium liberalium defensor indefessus, per tot annos inter tantas rerum vicissitudines animum serenum, aequum, prudentem, modestum conservavit.

[1] Cicero, "De Or.," i. 199.

Virum talem preconio eodem dignum esse crediderim, quo populi Americani praeses quidam magnus, professoris nostri in anno primo munus suum ingressus, populi sui a poeta eximio postea est laudatus :—

En vir benigne intentus, fortis, providus,
Sagax patiensque, laudem non culpam timens.[1]

On June 17, Lord Rayleigh was formally installed as Chancellor of the University in succession to the late Duke of Devonshire. At a luncheon given by the master and fellows of Gonville and Caius College to the Chancellor, the recipients of honorary degrees, and a large party of guests, Sir Andrew Noble announced that several of Lord Rayleigh's friends, non-resident members of the University, proposed, in order to express the gratification of the scientific world at his election, to offer to the University a fund large enough to provide an annual award to be associated with the name of the Chancellor.

The Harkness scholarship for 1908 has been awarded to T. O. Bosworth, and the Wiltshire prize to W. C. Smith. The John Winbolt prize has been awarded to L. B. Turner, for his essay on "The Elastic Breakdown of Materials submitted to Compound Stress." The examiners were also of opinion that the essay sent in by E. T. Busk was deserving of honourable mention.

The special board for biology and geology has approved a grant of 200*l.* from the Balfour fund made by the Balfour managers to J. Stanley Gardiner, in aid of researches in the Seychelles, Aldabra, and the neighbouring islands.

The professorship of chemistry is vacant by the resignation of Prof. Liveing. The electors will meet for the purpose of electing a professor on Saturday, July 25. Candidates are requested to communicate with the Vice-Chancellor on or before July 13.

OXFORD.—The Drapers' Company has offered to make a grant of 22,000*l.* for a new electrical laboratory at the University, and to contribute 1000*l.* toward its equipment. This generous offer will be brought before Convocation in October.

LIVERPOOL.—The council of the University has instituted two new chairs, one of Celtic studies and the other of mediæval archæology. Prof. Kuno Meyer, who already holds the endowed chair of German in the University, has been appointed to the first of these new chairs, and Mr. F. P. Barnard to the second.

A COURSE of lectures and demonstrations on the scientific study of fisheries has been started this summer session in the University of Aberdeen. It is being conducted by Dr. T. Wemyss Fulton, scientific adviser to the Scottish Fishery Board.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, April 30.—"A Photographic Determination of the Elements of the Orbits of Jupiter's Satellites." By Bryan **Cookson**. Communicated by H. F. Newall, F.R.S.

During the opposition of Jupiter in 1902, the author was engaged in making a series of measurements of the relative positions of the four Galilean satellites with the 7-inch heliometer at the Cape Observatory. Simultaneously with these visual observations, photographs were taken with the astrographic telescope. This paper contains a short account of the work done in connection with the photographs; a detailed account has appeared as vol. xii., part iv., of the "Annals of the Cape Observatory."

The investigation with the heliometer was undertaken with the object of determining the mass of Jupiter and correcting the best available elements of the orbits of the satellites, which observation showed were considerably in error.

The mass of the system of Jupiter, in terms of the sun's mass, was determined with great care from the heliometer observations. The value finally deduced is

$$1 : 1047{\cdot}30 \pm 0{\cdot}06.$$

[1] (Abraham Lincoln).
"The kindly-earnest, brave, foreseeing man,
Sagacious, patient, dreading praise, not blame."
Lowell's "Commemoration Ode," vi. *ad finem.*

In the case of the second satellite, which has an orbit at an inclination of 0°·48 to Jupiter's equator, the node retrogrades 12° per annum, and of this motion 82 per cent. is due to the compression of Jupiter, 4 per cent. to the influence of satellite I., 13 per cent. to that of III., and 1 per cent. to that of IV.

The fifth satellite discovered by Barnard is so near to the primary that the node of its orbit revolves through about 912° per annum, and second-order terms begin to make themselves felt. A careful measurement of this motion would be of much value, for a comparison of the compression of Jupiter, deduced from the motion of the node of V. with that deduced from the motion of the node of II., might provide information concerning the distribution of mass in Jupiter.

June 4.—"On the Decay of the Radium Emanation when dissolved in Water." By R. B. **Moore**. Communicated by Sir William Ramsay, K.C.B., F.R.S.

The results obtained by Ramsay and Cameron on dissolving radium emanation in water and in copper sulphate solution have made it advisable to investigate the behaviour of the emanation, when dissolved in such solvents, from a radio-active standpoint. The present note deals with the rate of decay of the radium emanation when dissolved in water. The emanation accumulated by 110 milligrams of radium bromide in two days, with the accompanying oxygen and hydrogen, was collected in a gas burette over mercury. After exploding, a small amount of water was run into the burette, and the solution of the emanation thus obtained, together with the slight excess of hydrogen, was transferred to a glass tube 2 inches long and 5 mm. in diameter, which had previously been exhausted. The solution filled about five-sixths the volume of the tube. The latter was sealed, and the decay curve of the emanation was obtained by means of the $\gamma$ rays, sheet lead being used to cut down the rays to the required amount. The half-time period found was 3·8 days. It may, therefore, be assumed that the emanation decays at the same rate when dissolved in water as it does in air.

**Geological Society**, June 3.—Prof. W. J. Sollas, F.R.S., president, in the chair.—The fossiliferous rocks of the southern half of the Tortworth inlier: F. R. **Cowper Reed** and Prof. S. H. **Reynolds**. This paper is a continuation of that on the igneous rocks of this area published in 1901 (Quart. Journ. Geol. Soc., vol. lvii., p. 267). The rocks are affected by the Hercynian flexures which produced the Bristol coal-basin, and the outcrop of the beds in the main follows the horseshoe-shaped outcrop of the Old Red Sandstone. This regularity is lost at Daniel's Wood and Middlemill. Two important transverse faults traverse the outcrops, which are further obscured by the overlap of unconformable Trias. The trap-bands are found to be confined to the Llandovery, the number of recorded fossils has been largely added to, and previous statements as to the thinness and imperfect development of the Ludlow rocks and as to the probable exposure of the district to erosion in Ludlow and Lower Old-Red-Sandstone times are confirmed.

**Chemical Society**, June 4.—Sir W. Ramsay, K.C.B., F.R.S., president, in the chair.—The interaction of copper and nitric acid in presence of metallic nitrates considered with reference to the existence of hydrates in solution: E. H. **Rennie**, A. J. **Higgin**, and W. T. **Cooke**. The authors consider that the acceleration caused by some nitrates and the retardation induced by others on the dissolution of copper in nitric acid are due to the withdrawal by the salts of water or nitric acid from the solution, and the consequent concentration or dilution of the acid.—The triazo group, part iv., allylazoimide: M. O. **Forster** and H. E. **Fierz**. Allylazoimide prepared in small yield and with some difficulty from allyl chloride and sodium azide is a mobile refractive liquid which boils at 76°·5 under 760 mm. pressure.—Aromatic arsonic and arsinic acids: F. L. **Pyman** and W. C. **Reynolds**. The following new substances are characterised:—bis-2-aminotolyl-5-arsinic acid, bis-2-acetylaminotolyl-5-arsinic acid, bis-*p*-aminophenylarsinic acid, and bis-*p*-acetylaminophenylarsinic acid.—Condensation products from aminopinenedicarboxylic acid: W. **Godden**.—A delicate test for bromides alone or in solution with chlorides: J. S.

**Jamieson.** The solution is heated with dilute sulphuric acid and potassium dichromate, shaken with chloroform, and the chloroform layer washed with water two or three times, and finally shaken with dilute potassium iodide. In the presence of a bromide the chloroform is coloured violet.—Experiments on the synthesis of *l*-methyl*cyclo*hexylidene-4-acetic acid,

$$CHMe\left\langle\begin{array}{l}CH_2.CH_2\\ CH_2.CH_2\end{array}\right\rangle C{:}CH.CO_2H,$$

part i.: W. H. **Perkin,** jun., and W. J. **Pope.**—A method for the measurement of rate of change in solid alloys. Preliminary note: G. D. **Bengough.**—Viscosity determinations at high temperatures: C. E. **Fawsitt.**—Dinitrodiphenylamine-*o*-sulphonic acid. Preliminary note: S. **Smiles.**—The study of the absorption spectra of the hydrocarbons isolated from the products of the action of aluminium chloride on naphthalene: Miss A. **Homer** and J. E. **Purvis.** These hydrocarbons (Trans. Chem. Soc., 1907, xci., 1103) have absorption curves which agree with the view that $C_{14}H_{16}$ is a naphthalene derivative, whilst $C_{10}H_{26}$ has a constitution similar to that of $\beta\beta$-dinaphthyl, and $C_{26}H_{22}$ that of an alkyl derivative of picene, and not of dinaphthanthracene, as had been previously suggested.—The synthesis and constitution of certain pyranol salts related to brazilein and hæmatein: W. H. **Perkin,** jun., R. **Robinson,** and (in part) M. R. **Turner.**—Brazilin, hæmatoxylin, and their derivatives, part ix., on brazilin, hæmatin, and their derivatives: P. **Engels,** W. H. **Perkin,** jun., and R. **Robinson.**—The effect of constitution on the optical activity of nitrogen compounds: R. W. **Everatt.**—The electrolytic oxidation of some hydroxybenzoic acids: A. G. **Perkin** and F. M. **Perkin.**—Note on morindin: A. G. **Perkin.** It is suggested that the morindin of *Morinda citrifolia* obtained by Oesterle and Tisza is different from that of *M. umbellata*, since it appears to be different in composition and to yield a different sugar on hydrolysis.—Some esters of arsenious acid: W. R. **Lang,** J. F. **Mackey,** and R. A. **Gortner.** Descriptions of a number of alkyl esters prepared by heating alcohols and phenols in contact with arsenious oxide, using a reflux condenser with a Soxhlet attachment containing anhydrous copper sulphate to remove water formed, are given.—α-Methylcamphor and fenchone: W. H. **Glover.** It is shown that α-methylcamphor and fenchone are essentially different in type, and on this ground exception is taken to Wallach and Semmler's formula for fenchone, which it is proposed should be represented as follows:—

$$\begin{array}{l|l}CH_2.CH_2.CMe & \\ & \quad CMe_2 \\ CH_2.CH\text{–}CO & \end{array}$$

.—Ester hydrolysis and theories of esterification: A. **Lapworth.**—Experiments on the formation and hydrolysis of esters, acetals, and allied compounds. Preliminary note: E. **Fitzgerald** and A. **Lapworth.**

**Linnean Society,** June 4.—Dr. D. H. Scott, F.R.S., president, in the chair.—Note on the spicules of *Chirodota geminifera*, Dendy and Hindle: Prof. A. **Dendy.** A correction to the paper recently published in the society's journal, Zoology, xxx. (1907), pp. 95–124.—The Caryophyllaceæ of Tibet: F. N. **Williams.** The collection was made during the recent military expedition to Lhassa, and it raised the known species to forty-three, from the eleven reported by Messrs. Hemsley and Pearson in the society's journal, Botany, xxxv. (1902), pp. 169–170. The route taken by the marching column was virtually unexplored previously, hence the number of novelties, namely, nineteen new species.—*Koonunga cursor*, a remarkable new type of malacostracous Crustacea: O. A. **Sayce.**—The Polychæta of the Indian Ocean: F. A. **Potts**; and the Stylasterina, from the same, elaborated by Dr. S. J. **Hickson** and Miss Helen M. **England.**—A contribution to the mycology of South Africa: W. N. **Cheesman**; with a supplement by T. **Gibbs.**

EDINBURGH.

**Royal Society,** June 1.—Dr. John Horne, vice-president, in the chair.—Note on some points in the anatomy of a Trilobite, *Calymene blumenbachii*: Dr. Malcolm **Laurie.** The "hypostome" in Calymene does not articulate with the doublure of the carapace. The margins turn back and articulate about one-third of their length from the front with the inside of the glabella. Movement on this joint draws the front of the hypostome away from the doublure, with which it is connected only by a membrane. There is also a plate articulated by a round joint behind the rostral plate which seems capable of turning into a horizontal position. It becomes a question whether the mouth in this form was in front of or behind the "hypostome."—Experiments with Heusler's magnetic alloy: J. G. **Gray.** The points mainly investigated were the magnetic properties of the alloy between 0° C. and 400° C., and the effects of quenching after heating to high temperatures, and of cooling in liquid air. The effect of the low temperature was to increase the susceptibility. In this respect it resembled Hopkinson's nickel-iron alloy, which begins by being non-magnetic at ordinary temperatures, but becomes magnetic after having been cooled to about −50° C. This result is the more curious inasmuch as Hopkinson's alloy is composed of magnetic materials, but is non-magnetic at the start, whereas Heusler's alloy is magnetic, but is composed of non-magnetic metals.—Note on the electrical resistance of spark gaps: Dr. R. A. **Houston.** The method employed was by use of the resonance curve after the manner introduced by Bjerknes. The resonator was adjustable, and the maximum resonance was detected by means of a galvanometer deflection produced by a thermo-couple, which was heated by the discharge. A deflection was also taken when the resonator had its self-induction slightly altered on each side of the adjustment for the maximum effect. From these and other data the logarithmic decrement of the oscillator can be calculated by means of a formula due to Drude, and thence, knowing the capacity and self-inductance, we can estimate the resistance of the spark gap. Results were obtained for different materials of the electrodes (zinc, aluminium, cadmium, tin, iron, &c.), and for various lengths of spark gap. These were somewhat irregular, but in the case of nickel and aluminium increase in length of spark caused a striking decrease in the decrement.—Treatment of aneurism by electrolysis: Dr. Dawson **Turner.** The many attempts to utilise electrolysis in aneurisms have been made in the hope that clotting might occur round the pole and thus serve as a nucleus for further coagulation and deposits of fibrin, with partial filling of the aneurism cavity. The experiments showed that silver and platinum, which have been mostly used by surgeons, had no action of the kind desired, and, besides, gave off gas bubbles in quantity. There is similarly no advantage in using iron or nickel, for no precipitates are formed. Lead, copper, and zinc, however, all produce precipitates, and of these zinc is to be preferred, both because of the character of the precipitate and because of the complete absence of gas bubbles.—Dr. Dawson **Turner** also exhibited some of Prof. Leduc's photographs of growth due to osmosis, and the microscopic structure of such growth.—The "negative viscosity" of aqueous solutions: Dr. W. W. **Taylor** and T. W. **Moore.** The results brought forward in this paper proved the insufficiency of any of the recognised explanations of this phenomenon.

PARIS.

**Academy of Sciences,** June 16.—M. H. Becquerel in the chair.—A partial differential equation relating to a closed surface: Emile **Picard.**—Researches on the rotation and lustre of the various atmospheric layers of the sun: H. **Deslandres.** A description of a modification of the method given in 1902 for the study of the rotation of the planets, and now applied to the sun. Instead of rotating the spectroscope, which becomes inconvenient with the large dispersion possible for the solar rays, the image of the sun upon the slit is inverted by a suitably mounted prism. The results of comparisons of the iron and cobalt lines (λ 3935·96 and λ 3936·12) and the calcium line $K_3$ lead to the conclusion that the upper layers of the solar atmosphere vary considerably in the velocity of rotation, and these may be different in the two hemispheres.—The organs and mode of vegetation of the Neuropterideæ and other Pteridosperms: M. **Grand'Eury.**—The ninth campaign of the *Princesse Alice*: the **Prince of Monaco.** This voyage in the Arctic regions lasted from June 16 to September 12, 1907, and was much hindered by unusual quantities of ice and by fog. Work was done in the fields of meteorology, oceanography, geography, zoology, and physics. A curious fact with regard to Lumière autochrome plates is noted. Commencing at about latitude 60° 40′ N., a blue veil appeared on the plates, increasing in intensity with the progress north up to the highest point reached, 79° N. The inverse effect was noted on the return south.—Bilinear forms: M. **de Séguier.**—The partial differential equation of vibrating membranes: S. **Sanielevici.**—The flocculi of hydrogen photographed with the rays $H\alpha$ and $H\delta$: G. A. **Hale.** The flocculi appear to move less rapidly than the gaseous atmosphere in which they float.—The apparent dispersion of light in interstellar space: Pierre **Lebedew.** The experimental results on variable stars obtained by Ch. Nordmann, and confirmed by G. Tikhoff, have been explained by these authors by the hypothesis that light undergoes a dispersion in interstellar space comparable with the dispersion in air at a pressure of 7mm. at 0° C. In the present paper this hypothesis is shown to be improbable and unnecessary.—An arrangement for the study of the sensitiveness of electrolytic detectors: P. **Jégou.** The method described does not require the mental comparison of the loudness of a sound heard in the telephone with a sound previously heard under another set of conditions. The instrument figured gives readings on an arbitrary scale corresponding to no sound in the telephone. The apparatus has been applied to study the effect of temperature on the sensitiveness of the electrolytic detector.—The photography of speech: M. **Devaux-Charbonnel.** A microphone is placed in series with a battery and an oscillograph, and the movements of the latter photographed. A study of the vowels showed that the curves are always the same for each, provided that care be taken to pronounce them in the same manner. This condition was easy to fulfil for I and U, more difficult for A, O, E′, and most difficult for the mute E.—The ultimate rays of the metalloids: tellurium, phosphorus, carbon, silicon, and boron: A. **de Gramont.**—Researches on the solubility of silver iodide in ammonia: H. **Baubigny.** In previous determinations of this constant sufficient care has not been taken to define the temperature and the strength of the ammonia. At 16°, in ammonia of density 0·926, the solubility is of the order of 1/6000, or less than half the solubility usually accepted.—Ammoniacal chloride of arsenic: MM. **Besson** and **Rosset.** The composition of the compound formed by the action of ammonia on $AsCl_3$ is held to be $AsCl_3.4NH_3$. The products separated by M. Hugo by the action of liquid ammonia do not correspond to the original compound, the liquid ammonia behaving rather as a reagent than as a solvent.—The alkaline chloroiridates and chloroiridites: Marcel **Delépine.**—The hydrates of the phosphoric acids: H. **Giran.**—The hydrates of the fatty acids: D. E. **Tsakalotos.**—Colloidal barium sulphate: A. **Recoura.** A solution of sulphuric acid in pure glycerol is neutralised with barium ethylate. The liquid remains limpid, and diluted with ten times its volume of water gives a colloidal solution of barium sulphate, without any precipitation taking place. Solutions of metallic salts, with the exception of mercuric chloride and salts of barium, determine the precipitation of the sulphate.—Constitution of the tetramethyldiaminobenzhydrylmethylenic compounds. The replacement of the hydroxyl of Michler's hydrol by the alkylmethylenic residues: R. **Fosse.**—The action of alkalis on mono- and di-methylarsinic acids and on their iodo-substituted derivatives: M. **Auger.**—The lactone of 3:4-dioxybutyric acid: P. **Carré.** Details are given of the most advantageous method of preparing the dioxybutyric acid from monochlorohydrin, and of the isolation of the lactone.—The double phosphate of magnesia and monomethylamine: Maurice **François.** Magnesium phosphate cannot be employed to separate ammonia from methylamine, since the latter forms a double phosphate analogous to the ammonio-phosphate. Magnesium phosphate in excess can be used to separate ammonia or methylamine from di- and tri-methylamine.—A modification of the properties of gluten in presence of sulphurous acid: J. **Dugast.**—The increase of the vital capacity and thoracic perimeter in children: M. **Marage.** A set of respiratory movements was taken by the children for five minutes twice daily. The beneficial effects were very marked, and are set out in tabular form.—The action of the zinc ion in microbial media: Joseph **Mendel.**—Contribution to the study of the constitution of proteid materials. A new method of hydrolysis with hydrofluoric acid: L. **Hugonenq** and A. **Morel.** Hydrofluoric acid at 20 per cent. strength, and at the temperature of the water bath, possesses many advantages as a reagent for the hydrolysis of proteid materials. It gives a complete hydrolysis, and causes less secondary changes than the reagents at present used.—Researches on the hybrids of barley: L. **Blaringhem.**—The hovering of birds: P. **Amans.**—Reply of M. Marcel **Deprez** to the criticism in the preceding note.

## DIARY OF SOCIETIES.

*THURSDAY*, JUNE 25.

ROYAL SOCIETY, at 4.30.—Have Trypanosomes an Ultra-microscopical Stage in their Life-history? Colonel D. Bruce, C.B., F.R.S., and Captain H. R. Bateman.—A Search for Possible New Members of the Inactive Series of Gases (Introductory Note to the Papers by Mr. H. E. Watson and Prof. R. B. Moore): Sir William Ramsay, K.C.B., F.R.S.—A Further Investigation of the Lighter Constituents of the Atmosphere: H. E. Watson.—An Investigation of the Heavier Constituents of the Atmosphere: Prof. R. B. Moore.—On the Atomic Weight of Chlorine: Dr. E. C. Edgar.—Note on the Vapour Pressure and Osmotic Pressure of a Volatile Solute: Prof. H. L. Callendar, F.R.S.—Eutectics Research No. 1, Alloys of Lead and Tin: W. Rosenhain and P. A. Tucker.—The Emission and Transmission of Röntgen Rays: G. W. C. Kaye.—Further Note on a Luminous Glow generated by Electrostatic Induction in an Exhausted Vessel made of Silica: Rev. F. J. Jervis-Smith, F.R.S.—The Action of Chlorine upon Urea whereby a Dichloro Urea is Produced: Dr. F. D. Chattaway, F.R.S.—On the Reflection of Waves from a Stratum of Gradually Varying Properties, with Application to Sound: Dr. J. W. Nicholson.—Preliminary Account of the Habits and Structure of the Anaspididæ, with Remarks on some other Freshwater Crustacea from Tasmania: Geoffrey Smith.—The Ω-Functions—a Class of Normal Functions: E. Cunningham.—And other papers.

*MONDAY*, JUNE 29.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Some Aspects of the Nile Valley: Capt. H. G. Lyons, F.R.S.

*WEDNESDAY*, JULY 1.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.

## CONTENTS.

THURSDAY, JULY 2, 1908.

## DEVELOPMENT OF ASTRONOMY.

*A History of Astronomy.* By W. W. Bryant. Pp. xiv+355. (London: Methuen and Co., n.d.) Price 7*s.* 6*d.* net.

IT is somewhat difficult to decide on the attention to be devoted to a volume so small as the present one, as it is from the first apparent that as a "history" justice could only be done even to a few sections of the subject. The intention of the author appears to have been to give a more or less popular account of the evolution and progress of the chief divisions of the science, without attempting to render the story complete. Starting with a short review of the astronomical notions of the early races, in the first two chapters the various claims to priority of record are examined, the Chinese data purporting to extend back to 2500 B.C.; the Indian system has tables, &c., supposed to be based on phenomena of the year 3102 B.C.; Egypt and Chaldea are also of very great antiquity, the latter recording the eclipses observed at Babylon in 721 and 720 B.C. In chapters iii. and iv. the advances made by the Greeks and Arabian philosophers are briefly reviewed. The Arabs excelled in methodical accuracy, and modern astronomy owes them an immense debt for the introduction of the decimal notation, replacing the more cumbersome numerical notations of the Greeks and Romans.

The end of these two schools brings the record down to the fifteenth century, when the great revival of philosophical thought in Europe commenced to be widely felt. The work of Copernicus, who was born at Thorn, in Polish Prussia, in 1473, was published in 1543, and practically inaugurated a new era, in that the Ptolemaic system was shown to be inadmissible, and the new Copernican system soon forced its way to the front, as it explained many phenomena which previously gave difficulty. Copernicus, however, was but a theorist, and it was by Tycho Brahe, born of a noble Danish family in 1546, that the great observational advancement of the sixteenth century was made. The story is then continued, giving the successive advances made in turn by Kepler, Galileo, Newton, Laplace, and the seventeenth and eighteenth century early astronomers Flamsteed, Halley, Bradley, and Herschel. Up to this stage the treatment has been chronological, but from this point the author, apparently finding difficulty in correlating the overwhelming flood of new observations which marked the end of the eighteenth and the whole of the nineteenth century, takes a series of subject divisions, and gives the main features of progress in both theory and observation relating to each. This naturally leads to various redundancies, and we doubt if the non-expert reader will obtain a clear idea of the chronological progress during these later times.

Chapter xv. is devoted to the modern development of observatories and instruments, which is very interesting reading. No mention is made, however, of the great influence on instrument design which has resulted from the use of the horizontal telescope in conjunction with a moving mirror of the Foucault siderostat or Lippmann cœlostat type, as is done at Paris, London, and at several stations in America. Chapter xvii. deals with the discoveries connected with the physical nature of the sun, the periodicity of the sun-spots, faculæ, &c. In the two following chapters the spectroscopic researches in connection with the sun are related from the time that Kirchhoff made his historic observation of absorption in 1859. Naturally the enormous development of this branch of astronomy since the 'eighties has made it impossible for the author to give more than a superficial narration of the progress made, but what he has included is both useful and interesting.

Chapters xx. to xxvi. deal with the individual members of the solar system. Most of this calls for little comment; in the chapter on Mars, predominance is given to the "carbonic acid" theory of the polar caps, but as we know from the recent researches of Lowell, it is now conclusively proved that water vapour in quantity does exist on the planet, and it is therefore unnecessary to discuss the more improbable theory. The concluding remark in this chapter is somewhat ungracious in an impartial review of the history of the subject; scepticism regarding the Lowell Observatory announcements is practically non-existent in the minds of anyone competent to appreciate the work done at that institution. Although open-minded in general, remarks like this show a tendency to urge an isolated opinion on matters requiring very wide discussion. In general, it may be said that these chapters on the solar system are very well up to date, and a short *résumé* is added giving the more modern theories of cosmogony, in which the simplicity of the original nebular hypothesis of Laplace has gradually given way to more modified views, no one of which, however, is at present definitely accepted.

Comets, meteors, and the Zodiacal Light are dealt with in chapter xxvii., the various cometary theories being very ably described without introducing any technicalities. Chapters xxviii.–xxxii. are occupied with the history of stellar research. The introduction and design of star catalogues of various degrees of precision, down to the great international *Carte du Ciel*, zone work, observations of proper motion and parallax, double star systems, variable stars, clusters and nebulæ, &c., are described in their order of development. The penultimate chapter, on stellar spectroscopy, occupies but twelve pages, reviewing briefly the classifications of Secchi, Vogel, Pickering, Lockyer, and Huggins. A curious statement is that the star Sirius has but little atmosphere, as indicated by its thick hydrogen lines and thin metallic lines. Surely the opposite is the case; for the hydrogen absorption lines to be so wide requires a very extensive atmosphere, at the base of which there must be a very considerable gravitational pressure. Little mention is made of the enormous progress made during recent years by the investigations of "enhanced lines" in stellar classification, although this is now



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accepted as a criterion for the differentiation of several of the stellar groups.

Approached with the above reservations the volume is certainly attractive, and the only serious omission appears to be the complete absence of references to sources of the information, so that a reader desirous of further study on any point is left entirely unaided.

The plates chosen for illustrating the volume are excellent and beautifully reproduced. The usefulness of many of them to the beginner will be somewhat impaired on account of the orientation letters being entirely omitted, and in several cases the plates are oriented differently from the majority, thereby leading to further confusion. Illustrations of many old portraits and ancient impressions of the solar and stellar systems are included, which will be the more interesting in that they are not easily available elsewhere. The index, well planned in general, contains many useless references, in some cases quoting names which, when referred to, prove to be merely names with no record of work done or other points of interest.

It will thus be evident that opinions on the volume will probably diverge along two lines; to the more advanced reader it is likely to appear superficial, as only touching with note-like brevity a few of the many chapters of the science; to the reader merely interested in astronomical development, however, it should appeal as a popular and very attractive account of many interesting sections of nature-study.

## *VON RICHTHOFEN'S CHINESE DIARIES.*

*Ferdinand von Richthofen's Tagebücher aus China.* Ausgewählt und herausgegeben von E. Tiessen. Two vols., illustrated. Vol. i., pp. xv+588; vol. ii., pp. iv+375. (Berlin: Dietrich Reimer, 1907.) Price 20 marks.

WHEN Ferdinand von Richthofen's life was ended his great work on China still remained unfinished. The third volume was not only unwritten, but had become unwritable, for, besides a description of southern China, it was intended to contain an account of the culture, civilisation, and organisation of China as a whole, and, apart from the magnitude of the subject, the complete alteration in the conditions of this "unchanging" country since the date of his travels had made much of his observation and experience inapplicable to the existing state of affairs. Besides the missing volume of his great work, von Richthofen also left unfinished the popular account of his travels, a work which he regarded as a duty owed to his fellow-men by every traveller in unexplored or little-known countries, and had, indeed, nearly half completed when the publication of his great work was assured, and monopolised the whole of the time and energy which was not devoted to his duties as professor. To fill in, so far as was possible, these gaps in his published work, and to meet a generally felt wish among Baron von Richthofen's old students and friends, Herr Tiessen, with rare skill, has compounded from von Richthofen's unpublished manuscripts, his diaries, and his letters home, one of the most interesting and enlightening books of travel which have been published.

On August 3, 1868, von Richthofen left San Francisco with the deliberate intention of undertaking a geological examination of China. His hope was that if he could manage to spend a year in that country he would be able, by the importance of the results, to interest the Government and obtain from it the assistance needful for the prosecution of his purpose. This first year of work was provided for by the enlightened liberality of Californian capitalists, who foresaw the practical importance of a scientific investigation of the resources of China, and, through the Bank of California, provided funds for an expedition. Arriving in China, von Richthofen was soon disillusioned of any hope of assistance from the Government, but nevertheless, and in spite of every discouragement, determined to pursue steadfastly his resolve. After some short excursions, mostly devoted to the examination of real or reputed discoveries of coal or ores, his first important journey was the descent of the Yangtse and the examination of its banks from Hankow to its mouth. This journey was an important one in more than one way, and in none more so than in the acquisition of Paul Splingaert, a Belgian, who had acquired an intimate colloquial knowledge of the Chinese language and an insight into the character and habits of thought of the Chinese people. The value of his services appears repeatedly throughout the book, and the importance of the results of von Richthofen's travels is very largely due to the fortunate combination of the man who knew how to collect and utilise information with the man who was able to obtain it. On this journey, too, von Richthofen made the first of those observations on the loess which led to the development of his well-known and now generally accepted theory of the origin of that remarkable formation; between Nankin and Chin-kiang he found remains of Helix in the loess near the hill of Fangshan, and remarks that this discovery is inconsistent with the theories of Pumpelly, who regarded the loess as a fresh-water, or of Kingsmill, who looked upon it as a marine, deposit.

The next journey took him through the province of Shantung, where he discovered large and important coalfields, and was the first to recognise the value of Kiao-chau as a port of access to, and an outlet for, the mineral wealth of the province, a discovery of which the German Government took advantage at a later period. After a long journey through Mongolia to Pekin and back to Shanghai, he accepted a proposal from the Shanghai Chamber of Commerce for an exploration of the interior of China; and so, in spite of the failure of his hopes of Government support, von Richthofen found himself in a position to carry out the design with which he left America, and on January 1, 1870, set out from Canton on the first of his two great journeys through the heart of the Chinese Empire, which ended with his return on May 21, 1872, to Shanghai; whence, after a stay of five months, devoted to preparing a report on his travels for the Shanghai Chamber of Commerce, he returned to his native land after an absence of just over twelve and a half years.

These are the travels of which we are given a simple and straightforward account devoid of all scientific technicalities. Those who wish to make use of von

Richthofen's scientific work must look elsewhere; but in this book they will find, not only an interesting account of his journeys, but a marvellous revelation of the real China. On almost every page of the narrative stand prominent, not merely the sources of China's weakness, but also the enormous latent power of the country, and there is borne in upon one an almost oppressive feeling that a China awakened, reformed, and patriotic could set the world at nought, and a China ambitious besides would be a real yellow peril. But all those who knew the late Baron F. von Richthofen will value this book less for its description of China than as a picture of its author; on every page of the narrative his simplicity, honesty, and nobility of character stand forth, his steadfastness in pursuing the course he had set before him in spite of discouragement, the intrepidity and tact which extricated him from difficult and dangerous situations, when set upon and mobbed by the colliers in Shantung, when he visited the bitterly anti-foregn "university" of Yolushan, and especially in the extremely critical occurrence which put an end to his further travels, all stamp him as a true representative of that aristocracy, not merely of birth, but of intellect and character, which by common consent raises some individuals far above the level of the great mass of their fellow beings. No more acceptable or worthy memorial of their author could well have been contrived than these two unpretentious volumes.

## THE GENERA OF FLOWERING PLANTS.

*Genera Siphonogamarum ad Systema Englerianum conscripta.* By Dr. K. W. von Dalla Torre et Dr. H. Harms. (Leipzig: W. Engelmann, 1900–1907.)

THE completion of the "Genera Siphonogamarum," by Drs. K. W. von Dalla Torre and H. Harms, will have been welcomed by all students of the taxonomy of siphonogams—or, as we are still used to say, phanerogams—and no doubt also by many other botanists. Invaluable as Engler and Prantl's "Natürliche Pflanzenfamilien" is as the embodiment of the most recent researches in the systematic botany of phanerogams, it suffers from one serious omission, the lack of all references to the original descriptions of the genera and their subdivisions. To fill that gap was the primary object of the publication of the "Genera Spihonogamarum." At the same time it was intended to make the synonymy of the genera as complete as possible, and give a comprehensive description, on the one hand, of their disposition within the families and the Englerian system generally, and, on the other, of their subdivisions. Lastly, the work should serve as a catalogue for those botanical collections which are arranged after the "Natürliche Pflanzenfamilien"; and there is no doubt that in most respects the problem has been solved in an admirable way.

The book consists of two parts. The first part (pp. 1–637) is headed by an "Enumeratio Familiarum Siphonogamarum," and contains the disposition of the systematic units above the rank of species, whilst the second (pp. 638–921) is taken up by an "Index Nominum." The basis of the whole work is, as indicated in the title, Engler and Prantl's "Natürliche Pflanzenfamilien"; but where the disposition or the conception of the units has been superseded by more recent monographs, or otherwise proved untenable, due notice is taken of the changes entailed thereby. The decision whether a proposed alteration was to be adopted or not must frequently have been a very difficult and delicate task for the authors; but, on the whole, they seem to have acted with much tact and sound judgment. The genera are given their successive numbers in the system in heavy type, whilst their places within the families are indicated by figures in light type. The references in the index are to both sets of numbers, which makes the index very handy as a collection catalogue. All citations are accompanied by the dates of publication, so that the settlement of questions of priority is greatly facilitated. The reference to the original publication is followed by references to Endlicher's "Genera Plantarum," Bentham and Hooker's "Genera Plantarum," and Engler and Prantl's "Natürliche Pflanzenfamilien," and by a note containing the approximate number of species known, and a very concise indication of the geographical distribution. Then the synonyms are enumerated in their chronological sequence, each starting a fresh line, and lastly we are given the disposition of the subdivisions of the genus with the corresponding synonyms.

Frequent use of the book has revealed here and there errors, almost exclusively in the reference figures, but not more than one has to be prepared for, in a work that contains almost 43,000 names, with as many references. There is, however, one weak point which cannot be passed without criticism. As the references to the two "Genera Plantarum" of Endlicher and of Bentham and Hooker stand, they suggest that a given genus admitted by the authors of the "Genera Siphonogamarum" is also admitted as such by those earlier authors, whilst in fact it merely means that they have dealt with it in some way on the page quoted, and, indeed, frequently stated that they do not consider the genus as tenable. For instance, under Ligularia we find "B.H. II., 449," but if we turn to p. 449 of vol. ii. of Bentham and Hooker's "Genera Plantarum," we find that Ligularia is there actually reduced to Senecio. Thus the impression is created that the conception which the authors of the "Genera Siphonogamarum" have of Ligularia is supported by the authors of "Genera Plantarum," whilst just the opposite is the case. The addition of "sub Senecione" in the case quoted would have been sufficient to make that clear. This is, however, practically the only serious blemish in a work which must have taxed the judgment and patience of the authors to the utmost.

The execution of the typography in a book like the present is, of course, of paramount importance, and it may be stated at once that it leaves nothing to desire, with the possible exception that the type used in the "Index" for the numbers of the genera admitted might have been a little heavier. Inconvenient is the throwing together in the index of the letters I and J, for which there is no justification. It must lead to confusion, and the authors have fallen into their own trap, for instance, in writing Jonidium for Ionidium (ἴον-ἴδ-ιον). And why Rhaphanus instead of the Linnæan "Raphanus," and on the other hand Raphia and Rigiostachys (ῥαφίς and ῥίγιος, στάχυς) instead of Rhaphia and Rhigiostachys? There is everything to be said in favour of rendering ῥ throughout by "rh"; but if this rule is not adopted, it would be better to adhere to the original spelling of the authors.

Those who have watched the nomenclatoric movement of the 'nineties and the first years of the present decade with some apprehension lest the continuity and uniformity of botanical nomenclature should be seriously impaired will be greatly relieved in finding on the examination of the "Genera Siphonogamarum" that this danger is practically averted. The book was finished up to the "Index," when, in 1905, the Vienna Congress adopted the new rules concerning the nomenclature of phanerogams; but in as far as these rules coincide in all essential points with the so-called Berlin rules which governed the nomenclature of the "Natürliche Pflanzenfamilien," the generic nomenclature of the "Genera Siphonogamarum" may well be considered as a practical and comprehensive test of the working of those rules. This being so, it is highly gratifying to see that the concord in generic nomenclature of the two leading schools of systematic botany, the older Kew school and the younger Berlin school, is practically absolute. Out of the total of, roundly, 10,000 genera, there are only 86 in regard to which the nomenclatoric standard of the "Genera Siphonogamarum" and the Kew practice, judged by Bentham and Hooker's "Genera Plantarum" and the "Index Kewensis," differ, and most of them are small genera, with few exceptions affecting none but purely scientific interests. Moreover, most of these discrepancies admit of easy correction, and where there is any serious doubt it may be left for the next International Botanical Congress to decide. This surprising concord in the generic nomenclature of the phanerogams is a veritable triumph of common sense which, it may be hoped, in the interest of science, will in time also conquer the opposition of the American school, which still holds out for a nomenclature of its own.

OTTO STAPF.

## *SCIENCE IN THE TEXTILE INDUSTRIES.*

*The Structure of the Cotton Fibre in its Relation to Technical Applications.* By Dr. F. H. Bowman. Pp. xx+470. (London: Macmillan and Co., Ltd., 1908.) Price 8s. 6d. net.

THE manufacture of a textile fabric mainly consists of a series of mechanical processes whereby the raw fibrous material is transformed first into a coherent thread and finally into a complex structure. As might be expected, therefore, the introduction of scientific method into the textile industries has mainly shown itself on the mechanical side, that is, in the improvement of the machinery used in the various stages of manufacture, much of which has been developed to a high state of perfection.

There are, however, many other directions in which scientific investigation can be directly brought to bear in textile manufacture, and the author of the book under review was a pioneer in one such direction thirty years ago, when he first investigated the microscopical structure of the cotton and wool fibres in relationship to the various processes of spinning, weaving, dyeing, and finishing.

The present volume, dealing with the cotton fibre, is the first of a series of three, and those to be subsequently issued will deal with wool, silk, &c. It comprises a very full account of the origin and development of the cotton fibre, its microscopical structure, and the chemistry of cotton cellulose and its derivatives. These chapters are followed by others giving details regarding the strength and variation of the fibre and of spun yarns of various counts and twists. Other less satisfactory sections deal with the various theories of dyeing and with dyeing processes, and in a final chapter the methods of detecting various fibres and of analysing a mixed fabric are described. Of the eighty illustrations and diagrams with which the book is illustrated, many are coloured, and, like the paper and type, are excellent. An exhaustive table of contents and trustworthy index add to the value of the book, and the introduction of a glossary shows that the author has spared no trouble to make the book complete. Some of the definitions in the latter would, however, bear revision, *e.g.* "*Complementary colour*—the remaining colours in a beam of light which are necessary to make white light." "*Hydroxyl*—the substance produced by the union of a single atom of hydrogen and oxygen."

One of the first duties of a reviewer is considered to be that of pointing out errors and omissions in the book with which he is dealing. This at any rate has the advantage of indicating that he has read the book with some care; and it may be mentioned therefore that there are misprints on line 1, p. 57, and on line 4 of the table on p. 150. Also that incorrect formulæ are given for cellulose on pp. 144 and 145, and for nitrobenzoic acid on p. 407.

Perhaps the most valuable feature of the work is to be found in the record which it contains of the author's laborious and long-continued investigation of the microscopical structure of cotton both during growth (for which purpose he cultivated cotton plants in a greenhouse), when fully matured, and at all subsequent stages of manufacture. Dr. Bowman's sketches showing the structure of fibres have been long accepted as standards, and have been reproduced in nearly all modern works on spinning, dyeing, &c.

Another highly commendable feature is the insistence upon due regard being paid to the interdependence of the various processes of manufacture. This is a point the importance of which is frequently overlooked, but one which, as the author states, is essential to perfection of result.

The issue of the remaining two volumes of the series will be looked forward to with much interest.

WALTER M. GARDNER.

## OUR BOOK SHELF.

*The Geology of Coal and Coal-Mining.* By Walcot Gibson. Pp. x+341. (London: Edward Arnold, 1908.) Price 7*s.* 6*d.* net.

THIS book is the first of a series of works on economic geology under the general editorship of Dr. J. E. Marr, F.R.S. The author is a recognised authority on the coal-bearing rocks of this country and of South Africa, and his introduction to the geology of coal is a welcome addition to technical literature that cannot fail to prove of great educational value to mining students. General principles of practical significance are dealt with in detail, and the world's coalfields are briefly described. The chemical and physical characters of coal are clearly explained, and chapters are devoted to coal as a rock, the formation and origin of coal, the distribution of coal, fossils as zonal indices, prospecting, the study of an exposed coalfield, and the study of a concealed coalfield. The coalfields of Great Britain are described in three chapters, dealing respectively with the southern, midland, and northern districts, whilst the remaining four chapters are devoted to the coalfields of Continental Europe, the North American coalfields, the coalfields of Africa, India, Australia, and South America, and the coalfields of China, Central Asia, Japan, New Zealand, and the Dutch East Indies.

The book is illustrated by eight well-reproduced plates of fossils. The palæontological chapter will undoubtedly prove most useful, as many mining engineers still fail to appreciate the value of fossil evidence, and the information given by the author will enable the student to see how far one part of the Carboniferous formation may be distinguished from the other. Besides the plates, there are in the text thirty-seven sketch-maps and sections of the various coalfields. Although somewhat crudely executed, these illustrations are clear and instructive. The least satisfactory chapter in the book is that describing the coalfields of Continental Europe, which is disfigured by a number of typographical errors, such as "Taplitz" for Teplitz, "Peckkohle" for Pechkohle, "Creusot" for Le Creusot, "Asturia" for Asturias, and by eccentricities in geographical nomenclature, such as "Pologne" for Poland, "Cracovie" for Cracow, and "the province of Oviedo in Asturia" for the province of Oviedo, or, as it was formerly termed, Asturias.

*Die Vegetation der Erde.* VIII. Grundzüge der Pflanzenverbreitung in Chile. By Dr. Karl Reiche. Pp. xiv+374. (Leipzig: W. Engelmann, 1907.) Price 30 marks.

THE first half-dozen volumes of the series were concerned with European regions, then followed a monograph on West Australia, after which comes the volume under notice. The State of Chile has been frequently visited by explorers, and among the early writings the histories by Padre Ovallo (1646) and von Diego de Rosales (1647) both claim attention for their phytogeographical descriptions. Subsequently the flora of the country has been studied by many scientific men, including Sir William and Sir Joseph Hooker; but to R. A. Philippi and his son must be accredited the first place in the exploration and identification of the botanical resources of the country, while in recent years the author has contributed in no small measure to a better and more accurate knowledge.

Apart from the consideration of characteristic plants arranged according to their orders, ecology is presented under the various aspects of vegetation forms, plant formations, biology and sketches of the vegetation. The latter are too detailed to convey definite impressions to the general botanist, being more suited to the traveller on the spot; but the morphological notes and catalogue of plant forms present a good idea of the most striking features met with in Chilian plants. Many of the parasites are remarkable, such as the species of Phrygilanthus and Cuscuta, and especially the unique *Pilostyles Berterii*, that lives entirely inside its host except when it thrusts out its small flowers; lianes abound, and various other climbing plants, while epiphytes are not so numerous, but the genus Tillandsia is interesting. The remarks on devices for checking transpiration are supplemented by drawings of leaf-sections, and the notes on the biology of the flowers and fruits are attractive. Comparisons are instituted with the floras of California, New Zealand, and the Argentine as a prelude to a discussion of the origin of the flora.

The author deserves a full measure of praise for the excellent and careful manner in which he has summarised the enormous amount of information contained in more than six hundred contributions. Two distribution charts and fifty reproductions of photographs add to the completeness of the work.

*From a Hertfordshire Cottage.* By W. Beach Thomas. Pp. viii+294. (London: Alston Rivers, Ltd., 1908.) Price 3*s.* 6*d.*

THIS recent addition to the numerous English books dealing with what has come to be known as nature-study is evidently the work of a careful observer of natural phenomena. To a first-hand knowledge of the open-air life of the country Mr. Thomas adds the power of clear and pleasing expression, and his collection of essays deserves to be read widely. The volume is in no sense a text-book; its design is rather to attract attention to the beauties and wonders of familiar natural objects. Some of the essays are sufficient evidence that scientific subjects can be described pleasingly in literary language.

*The Open Air.* By Richard Jefferies. With illustrations by Ruth Dollman. Pp. xii+234. (London: Chatto and Windus, 1908.) Price 5*s.* net.

ALL lovers of nature know the writings of Richard Jefferies, and admire his power of bringing a breath of country air, as it were, to accompany the reading of his essays. Many nature students, whether they have previously made the author's acquaintance or not, will delight in this volume. Miss Dolman has succeeded by her well-chosen and skilfully executed pictures in adding charm to work which was already beautiful.

*School Hygiene.* By Robert A. Lyster. Pp. viii+360. (London: W. B. Clive, University Tutorial Press, Ltd., 1908.) Price 3*s.* 6*d.*

THIS book "largely consists of the material of the various courses of lectures to teachers" in the West Riding and Midlands. But the chapters have none of the looseness usually associated with lectures. On the contrary, the book is succinct and well arranged. It incorporates much of the most recent work. It is well adapted for the training of teachers in school hygiene generally, as well as in the special personal hygiene that forms an indispensable preliminary to an effective system of medical inspection of school children.

*The Ethics of Nature.* By M. Deshumbert. Translated from the French by J. M. Hartmann. With an introduction by Henry James. Pp. 144. (London: D. Nutt, 1908.) Price not stated.

THIS little volume is filled with common-sense teaching. The morality advocated is based upon natural laws, errs rightly on the side of severity, and indicates many conflicts in which the best of men even will find effort enough necessary. Many problems are discussed which have engaged the attention of moralists in every age, and even if they are not solved, the method of dealing with them provides abundant food for thought.

## LETTERS TO THE EDITOR.

*[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.]*

### Uniformity in Lantern-slides.

In illustrating a scientific lecture it is important that lantern-slides produced from photographic negatives should be of uniform density, and should well exhibit the details which they are intended to illustrate. To blame the lanternist for faults which are not his own may give relief to the lecturer's feelings of disappointment, but this plan does not conduce to the success of the lecture.

For some time past I have been experimenting on photometric methods of comparing exposures in printing from negatives of widely different density, and I find that if the tests are made with sufficient care the results exhibit a remarkable degree of uniformity.

A simple photometer can be made of a sheet of white cardboard folded into the shape of an isosceles prism or double inclined plane, the faces of which are illuminated by sources of light placed on opposite sides of the prism, the distances of the sources being regulated according to the law of inverse square. Now let two negatives under comparison be placed side by side in front of the two faces, and examined by the transmitted light reflected from the cardboard. Then, when the negatives look to be of the same density, their exposures will be proportional to the illuminations of the faces, and can be easily compared. If the negatives differ in contrast, this difference will be at once evident on adjusting the illuminations, and either the necessary modifications of treatment can be decided on or badly contrasted negatives can be set aside for intensification or omitted from the series. By a method identical in principle with the above I have been successful in testing the development of negatives and in calculating exposures in bromide enlarging. Two negatives exposed in succession with calculated exposures of twenty-five seconds and fifty minutes have given under similar development equally good prints of almost exactly the same darkness.

G. H. Bryan.

### A Probable New Fluting in the Spectrum of Magnesium Oxide.

There appears to be a well-marked, though faint, fluting in the spectrum of magnesium oxide which has not been hitherto recorded, consisting of seven principal edges and several fainter lines. No mention of it has been found anywhere, and Prof. Kayser, who has seen a photograph, says that it is unknown. If so, this is probably due to the fact that it would be quite invisible against even a weak continuous spectrum.

The wave-lengths of the principal edges have been determined by comparison with lines of zinc, cadmium, and manganese, and are approximately as follows:—4823, 4819, 4810, 4801, 4791, 4780, 4771. The first of these is very faint, and although almost coincident with the Mn line at 4823, appears to have a slightly greater wave-length, and is probably not due to Mn as impurity. The edge at 4780 is rather diffuse, and two faint lines have been measured between it and 4791. Between 4771 and 4731, five lines have been measured, which may also belong to the system.

The fluting is obviously related to that beginning at 5007; the spacing between the edges is of the same order, and it is only well seen when the latter is very intense. Although first observed about twelve months ago, it was only successfully photographed last February. Some of the negatives also show that the series of faint, fine lines on the less refrangible side of the violet magnesium triplet extends much further into the visible spectrum than catalogued by Eder and Valenta.

E. E. Brooks.

Leicester Municipal Technical School, June 18.

### The Halos round Zircons in Biotite.

With reference to the action of radium on glass, and its removal by exposure to sunlight, the following unintentional experiment may possibly be of interest. Many years ago I had a section of a piece of granite prepared, and then another after the stone had been made red hot in an ordinary bright fire.

In the unheated rock the zircons in the brown micas show good halos, and these have not been obliterated by the strong heating. This may be worth mentioning, as the experiment may possibly not have been attempted by anyone else, either from lack of motive or the difficulty of getting a good slice after the rock has been made brittle by the heat.

A. R. Hunt.

Southwood, Torquay, June 20.

## LORD KELVIN'S PHILOSOPHY.[1]

*Explanation in Terms of Force or of Motion? Action across Empty Space or through a Medium?*

One of the most interesting and important outcomes of last year's meeting of the British Association at Leicester was the declaration by Lord Kelvin, during a memorable discussion on the constitution of the atom, in Section A, that he had found it necessary to abandon the attempt to contemplate the material universe explicitly in terms of æther and motion, and for his own part preferred to resort to the Boscovich doctrine of centres of force acting on each other according to some curiously complex law, without specific attention to the hypothetical medium in which such forces may exist.

Now undoubtedly these ancient postulates of matter and force represent the dynamical method first made feasible by Newton's achievement in celestial physics, whereby phenomena were correlated by unexplained particles of matter acted upon by unexplained forces, of statical origin and unknown mechanism, according to a specified law of distance. This was how Newton successfully solved the problems of gravitation, and constructed the working theory of astronomy; but it had been hoped, and by some is still hoped, that the time had now come for seeking to represent, in terms of something simpler and more fundamental, the nature of matter and the origin or inner mechanism of its various forces.

The most powerful and hopeful lever wherewith to attack this great philosophical problem was the kinetic theory of elasticity and rigidity, introduced by Lord Kelvin himself. By this means it has been hoped to express force in terms of the still simpler conception of motion; in fact, to explain all the forces with which physicists have to do—electrical and chemical attraction, elasticity, magnetism, cohesion, and perhaps gravitation—in terms of the internal motions of a universally connecting fluid plenum.

But now the question arises, is it at all certain that the material universe can really be understood in terms of motion alone—motion of an all-pervading continuous fluid known as the æther of space? And would such a solution be satisfactory?

To many it has seemed that this reduction to simplicity was the closest approach to ultimate explanation and unification that could be hoped for in the domain of mathematics and physics; and during the last half-century many steps, apparently in the direction of such an achievement, have been taken by the leaders in these branches of human knowledge.

The mathematical foundation was laid by Helmholtz, when he reduced rotational or vortex motion in perfect fluid under the domain of mathematics; it was followed up by Lord Kelvin's kinetic or gyrostatic theory of elasticity and rigidity; so that mathematicians, such as FitzGerald, Heaviside, Larmor,

[1] Being thoughts suggested by the meeting of the Mathematical and Physical Section of the British Association at Leicester in August, 1907; and referred to in Sir Oliver Lodge's recent Presidential Address to the Faraday Society, May 26, 1908.

Hicks, J. J. Thomson, and others, as well as Lord Kelvin himself, have, from various points of view, endeavoured to devise a scheme of spinning motion in a perfect fluid plenum which should be able to accomplish in general terms all that the æther is known to perform: more particularly that it should be able to imitate its faculty of transmitting the transverse or solid quiverings that we call light, yet without resisting the motion of bodies through it; and at the same time that it should be able to maintain its own turbulent or whirlpool motion in an unconfused and regularly stable condition throughout infinite time. And in this difficult undertaking they have from time to time seemed partially successful; at any rate, they have reached suggestive results and opened up stimulating vistas.

The ether must be incompressible, too, being perfectly continuous without breaks or any kind of atomic or granular structure, save such as may be conferred upon it by reason of its infra-material internal motion. An infinitesimally turbulent liquid of some kind seemed the desideratum, and many have been the attempts to devise such a liquid. An interlaced system of vortex fibres or filaments has to some seemed the most likely device; a similar scheme was a system of plates or laminar vortices; while a third modification conceived it as a collection of connected filaments all in a state of rapid internal motion, though stationary as regards locomotion in space;—what might be called a vortex sponge. By some such means it was hoped to be able to combine the elastic rigidity appropriate to a solid, with the penetrable unresistance to motion of solids through it, characteristic of a perfect fluid, and with the complete incompressibility of an ideal liquid. But the mathematical difficulties of all such treatment have been rather overwhelming; and an uncertainty about the stability or permanence of such a medium has always obtruded itself in a discouraging manner.

In fact, there has always been a troublesome amount of instability in all the schemes that have hitherto been devised, so that none of the expounders of the motion doctrine was able to announce a finally satisfactory result.

Still it was felt by most of those who have worked at the subject that the outlook in this direction would be so bright, if initial difficulties could be overcome, that it was worth a long-continued effort to see if a coherent scheme could be planned on these lines, so as to secure what, if it turned out to be the truth, would surely be a magnificent generalisation.

Indeed, it has sometimes seemed unlikely that a mode of explanation which offered such attractive features, and led so far in the right direction, could, after all, be a blind alley leading nowhere; or, to vary the metaphor, a mere will-of-the-wisp which it was waste of time to pursue.

What has certainly been made out is that motion of atomic structures, in an æther with elasticity postulated, supplies a complete working scheme on which we can rest without inquiring further as to the origin of this elasticity. Beyond this, the attempt to explain the material universe on a purely kinetic basis has not made much progress in quite recent years; and, to those competent to attack it, it has probably seemed better to let the problem lie dormant for a time, until future discoveries in mathematics or in physics threw more light upon the rocky path or provided us with better instruments for climbing it.

During the epoch of waiting it now appears that our venerated chief was deflected from further attempts in this direction, and directed his attention elsewhere. Other methods seemed to him more immediately hopeful; and whereas it had been hoped to explain force in terms of latent motion, Lord Kelvin in later years sought to expound motion in terms of force, giving up the kinetic unification of the material universe in favour of a conception more arbitrary and descriptive, and permitting himself to regard force as perhaps an equally fundamental, perhaps a more fundamental, conception than motion.

It may be that philosophers will concede the (to me) somewhat improbable proposition that an explanation in terms of force and action-at-a-distance will be as satisfactory as an elucidation in terms of motion and a continuous medium. To Lord Kelvin it would appear that both solutions were equally satisfactory, and that it was only a question of which was the most tractable. In any case it is noteworthy that he took up so clear and definite a position; it is the key to much of his recent work, and to the difficulties which he felt in accepting some of the hypotheses which are a natural consequence of the electrical theory of matter and of some of the facts of radio-activity. It now seems not unnatural that he should have sought to express and explain these great results otherwise. His attitude is both coherent and reasonable; though I would urge that most theoretical advance and discovery (in the hands of Maxwell and others) has been along the continuous and medium line, which, if not the line of ultimate explanation, is at any rate that of achievement.

At the same time, it must be admitted that, if a longitudinal impulse is transmitted by an incompressible medium at an infinite pace, the process becomes barely distinguishable from action at a distance, through a force varying according to a specified law. Or—putting what is virtually the same thought in another way—the influence of an electron, or matter-unit, whose field of force extends infinitely in all directions, need not be conceived as limited by some arbitrary boundary beyond which things can be said to be at a distance from it.

It will be remembered that some of the old philosophers saw great difficulties in the abstract conception of motion. It appears as a curious evanescent transition from one place to another, involving the attribute of "time"; it is indeed "not a being but a becoming," when position is taken as the primary conception.

But I urge that it is simplest to regard "position" and "distance" as secondary conceptions, subordinate to and arising out of our perception of motion. Unless motion is supposed to be a thing directly apprehended, it is truly rather an elusive idea. To me it seems a direct apprehension—direct information conveyed by our muscular sense. Space itself seems a *consequence* deduced from our perception of motion; and the idea of time follows from our direct perception of *rapidity* of motion. But probably to Lord Kelvin these things appeared otherwise.

The conclusion of the discussion on the constitution of the atom may be summed up thus:—

The internal energy of Lord Kelvin's model atom is static or potential. The internal energy of the hypothetical atom at which others are working is kinetic.

The disintegration of radium in the former case is comparable to the explosion of an unstable chemical compound, like gun-cotton. In the latter case it must be represented by something more akin to the flying to pieces of a single rapidly spinning unit, such as a fly-wheel.

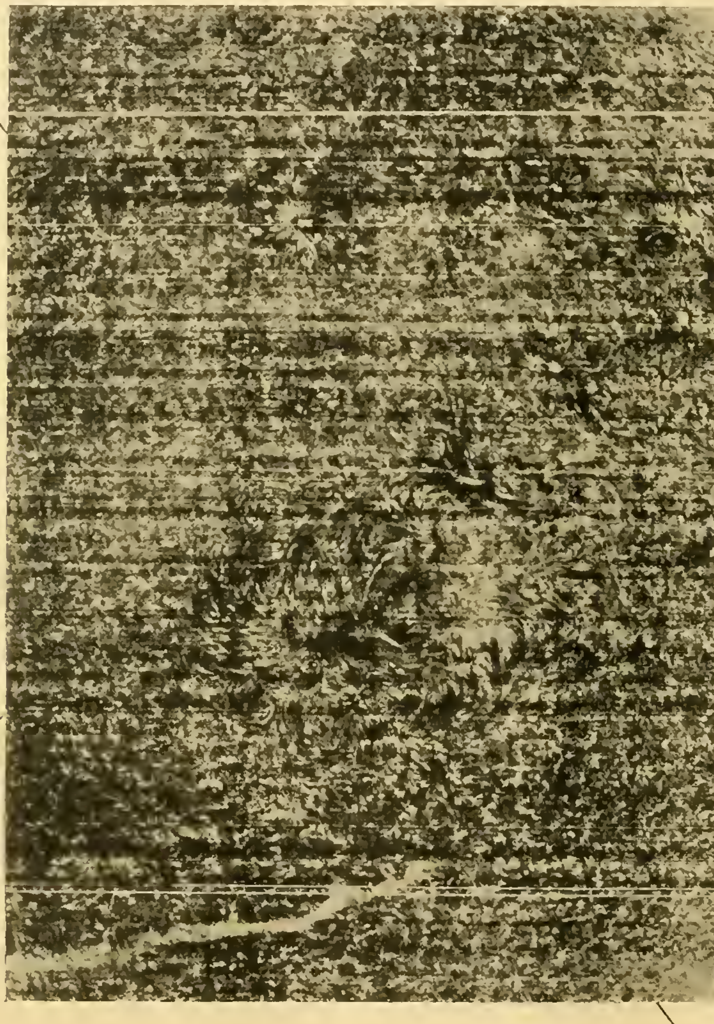
And so for the present the matter stands.

Oliver Lodge.

## RECENT WORK WITH THE SPECTROHELIOGRAPH.

PROFS. HALE AND ELLERMAN, of Mount Wilson Solar Observatory, California, enjoying the advantages of a climate almost unrivalled and an instrumental equipment of the highest class, have already given to the world scientific results worthy even of such a combination. In connection with their more recent work we have received several photographs, one of which is reproduced here. Among the photographs are discs of the sun in the light of iron (λ 4045), and an interesting comparison of the solar surface as seen through the calcium line ($H_2$) and the hydrogen line (Hδ), showing in a striking manner that the regions of maximum radiation of calcium light are regions of absence of hydrogen radiation.

In obtaining photographs of hydrogen flocculi, the hydrogen line Hδ has chiefly been used. In March, 1908, it was found possible, by the use of the new "Pan-iso" plates of Wallace, to secure photographs of the sun with Hα. The comparison of the resulting photographs with those taken in Hδ showed bright flocculi peculiar to Hα, and small dark areas appearing solely in Hδ. Using the various hydrogen lines for the photography of the chromosphere and prominences, the greatest intensity and extent were found in the photographs taken with Hα. These qualities decreased through the hydrogen lines Hβ and Hγ until in Hδ only the brightest parts of the prominences were shown. Considering the integrated hydrogen light of the disc, these facts indicate an increase of relative intensity in the Hα line, or, as put in the letter accompanying the photographs, show that "hydrogen appears in contiguous regions on the sun under some of the peculiar conditions which produce differences in the relative intensities of its lines observed in nebulæ and in stars having spectra of the Wolf-Rayet and other special types."




Negative of a portion of the solar surface in Hα light.

The feature of special interest in the photograph reproduced (which is a negative of part of the solar surface taken in Hα) is the strong suggestion of the existence of vortex systems surrounding the spots. The specially extensive and well-marked phenomena near the centre of the illustration, it is suggested, show that "the prominences surrounding this area . . . are swayed towards the centre, and their appearance strongly suggests the effect of a great whirl rotating clockwise" (*i.e.* N.W.S.E.).

It is to be noticed that the dark hydrogen flocculi appear bright on the negative as reproduced. The photograph was taken on April 30, 1908, 5h. 6m. p.m., Pacific standard time. A direct photograph secured on the same date shows a group of small spots near the centre of this region, while a plate in $H_2$ light shows a calcium flocculus lying above the spots. Neither of the above photographs affords any evidence of whirl. The remarkable features shown in the illustration are thus apparently confined to the higher regions of the solar atmosphere, and are selectively photographed by making use of the special qualities of the hydrogen line Hα, though the general appearance calls to mind the torn edges of a sun-spot as drawn by Langley.

The picturing by spectroheliographic means of the distribution of radiating matter at various solar levels is already well known. The photograph reproduced illustrates what can be done in quite a new way by using this valuable means of acquiring information about solar circulation.

It may be pointed out in passing that the appearances in the great whirl might be explained equally well, or perhaps even better, from the fining away *outwards* of the hydrogen flocculi, as an anti-clockwise whirl outwards from the centre. Occasionally on photographs in "K" light taken at South Kensington, some suggestions of extensive whirl systems surrounding centres of activity are observed.

The relation of the photography of high-level hydrogen flocculi to the recent work of Hale and Adams on the rotational velocities in various latitudes is full of promise and interest. It seems clear from the work up to the present that the retarding influence varying with the solar latitude felt by the spots and lower lying vapours is not operative on the high-level hydrogen.

The rainy season at Mount Wilson having ended, hopes are entertained that material for the further study of these extensive vortices may be obtained, and that the theories of Faye and Emden, both of which assign the origin of sun-spots to vortices, may be tested.

T. F. C.

## *AN INVESTIGATION OF THE SOCIOLOGY AND RELIGION OF THE VEDDAS.*

THE Veddas have long excited the interest of students, as they are generally believed to represent the aboriginal population of Ceylon, and to have remained at that low level of culture which characterises most of the hunting denizens of tropical jungles. Drs. P. and F. Sarasin first investigated the Veddas nearly twenty years ago, and published their results in an important monograph in 1892, which dealt mainly with the physical characters of the people. They put forward the view that the Veddas are the nearest living representatives of that stock from which the Australians, on the one hand, and the Dravidians, on the other, have diverged, and the term Proto-Dravidian has been applied alike to the Veddas and the race which they represent. Although a fair amount is known about the habits and material culture of these jungle-folk, it was felt that their sociology and religion should be thoroughly studied by a trained investigator before it was too late. The matter was brought before the Ceylon Council in the autumn of last year by the Hon. John Ferguson, C.M.G., and Dr. A. Willey, the director of the Colombo Museum, and a grant was made, which has since been raised to 500*l.*, to enable this investigation to be undertaken. Mr. Hugh Clifford, C.M.G., Colonial Secretary of Ceylon, whose interest in the jungle tribes of the Malay Peninsula is so well known, gave the application his warm support.

Dr. C. G. Seligmann was selected to undertake this investigation, for which he was thoroughly qualified by his previous field-work in New Guinea and elsewhere. Dr. Seligmann, accompanied by his wife, arrived in Ceylon in December last, and remained there for five months. During this time only one week was so wet as seriously to interfere with work, and the only real difficulty experienced was to obtain a supply of carriers during the rice harvest, and the period immediately preceding it.

It is, of course, impossible to give even a summary of the results of the expedition until they are published, but the following information will give some idea of the scope of the inquiry. Dr. Seligmann gave most of his attention to the less advanced Veddas, those whom previous writers designate as "jungle-" and "rock-Veddas," but this distinction does not seem to be warranted. The "village" and "coast Veddas" have become so modified by contact and mixture with other races that they do not afford a favourable field for the study of "primitive" conditions. The Veddas are divided into clans, some of which are definitely of inferior status to others, and have to perform certain duties for them; this unexpected circumstance seems to be of old standing. In the majority of communities exogamy is the rule, and with this is associated descent in the female line. In other groups descent is in the male line, and in these cases exogamy no longer exists. Cousin marriages on both sides are the rule, or should be, but the children of two brothers or two sisters may not marry.

The three things that loom largest in the native mind are hunting, honey, and the cult of the dead. The last constitutes almost the whole of the religious life and magical practices of the people; it is the *motif* of almost every dance, and, indeed, Dr. Seligmann is inclined to believe it was originally the source of them all. According to most Veddas, the spirit of every dead man, woman, or child becomes a *yaka* within a few days of death. Some Veddas, however, say that when ordinary persons die they cease utterly, and only a few strong and important men become *yaka*; but in either case the basis of an elaborate system of magic is "possession" by certain *yaka*, who are considered as historical spirits, though little more than their names and, in some instances, their dwelling-places are known. Some *yaka* send success in hunting, and the Seligmanns saw the whole thanksgiving ceremony over a fine buck, in which a ceremonial arrow with a blade more than a foot long and a handle scarcely longer played a prominent part. In some communities the *yaka* beliefs are strongly tinged, if not coloured, throughout by borrowings from what appears to be a simple and probably early form of Hinduism. Dr. Seligmann could not with certainty find any magical practices that were not based on communion with the friendly dead, except those which appear to have been borrowed from the Sinhalese. It is accordingly not surprising that it is generally considered necessary to present an offering to those recently deceased. This must consist of cooked rice and coco-nut scrapings; this food is difficult for them to get, but every Vedda esteems it above all other. The "shaman," called *kapurale* or *dugganawa*, calls upon the *yaka* of the recently deceased man to come and take the offering. The *kapurale* becomes possessed by the *yaka*, who, speaking through the former in hoarse, guttural accents, states that he approves of the offering and will assist his kinsfolk in hunting, often, indeed, indicating the direction in which the next hunting party should go. This is the simplest form of death ceremony, but besides the *ne yaku*, as the spirits of the dead are called, other *yaku* are invoked in most communities. Many generations ago there lived a Vedda, a mighty hunter named Kande, who on his death became Kande Yaka, and who is constantly invoked to grant success in hunting. The majority of Veddas believe that the *ne yaku* go to Kande and become in some sense his attendants. Now Kande Yaka is usually invoked at the beginning of the *ne yaku* ceremony, and in more than one community it was pointed out that the *ne yaku* would not come to the offering unless accompanied by Kande Yaka, who was sometimes spoken of as bringing them.

The mental characteristics of these jungle-folk appear extraordinary to one conversant with Melanesians, since they are really intelligent, and, when cross-examined, are equal to a sustained mental effort that would be beyond the possibility of the brainiest Papuan. The only examples of decorative art are rough rock-paintings in caves, and the village Veddas are incapable even of this slight proficiency in pictorial art. Personal adornment is of the slightest. The absence of tales and legends is almost unbelievable. Dr. Seligmann inquired on this matter of almost every elderly and not too civilised Vedda, and he obtained merely some thirty lines of bald statements which can scarcely be dignified by the name of legends.

Readers of NATURE will remember that their attention was directed to the recent discovery of stone implements in Ceylon, many chippings and implements having been excavated from Vedda caves. Dr. Seligmann has made collections of these, but in one cave which he excavated, out of some three hundred pieces of quartz about four per cent. presented definite appearances of having been worked. That particular cave had Sinhalese carving and stone masonry in and around it. Indeed, he has evidence that the Sinhalese were associated with so-called Vedda caves about the beginning of the Christian era. It seems that even among the "wild Veddas" there has been a much older and more intimate cultural connection with the Sinhalese than the literature of the subject would lead one to suspect.

Dr. Seligmann took a large number of photographs, many of which are very successful, but unfortunately the photographs of the dances of the least sophisticated community are not so satisfactory, as these Veddas would dance only in their usual dancing places, which are deep in the forest, where instantaneous work was practically impossible. A number of plates of the new colour process were taken out, but the results were not very satisfactory. A very complete series of phonograph records of songs were obtained, from lullabies to invocations to the dead. The great achievement of securing the songs of the women was due to the presence and cooperation of Mrs. Seligmann. An unexpected experience in working with the phonograph was its enormous popularity, not simply amazement or wonder, but sheer delight in it.

Many ethnologists have felt how desirable it is that trained women should make investigations in the field, since it was realised that information obtained by men, through men, about the practices and ideas of native women must necessarily be imperfect and biassed. The present expedition has conclusively proved the truth of this; indeed, the mere presence of a woman gave these shy and extremely jealous people such confidence that the Seligmanns were allowed to make their camps close to the Vedda caves. One of the groups of the "wildest" Veddas invited them to share the cave in which the whole community, including the girls and young unmarried women, were living; a surprising offer, as Neville, the most sympathetic of recent observers of the Veddas, records how, as a sign of extreme amity and confidence, he was once allowed to spend a few minutes in the company of the younger women of a community to whom he was well known. It is thus no exaggeration to say that had not Mrs. Seligmann accompanied her husband in this arduous expedition, the results would have been less numerous and important.

A. C. Haddon.

## NOTES.

The list of honours issued on the occasion of His Majesty's birthday includes the names of a few men distinguished for their work in pure or applied science. Baronetcies have been conferred upon Sir T. Lauder Brunton, F.R.S., and Dr. W. Watson Cheyne, C.B., F.R.S. The honour of knighthood has been conferred upon Prof. A. G. Greenhill, F.R.S., Colonel David Bruce, C.B., F.R.S., and Mr. R. A. Hadfield, president of the Iron and Steel Institute last year. Mr. W. H. Power, F.R.S., has been promoted to the rank of K.C.B., Dr. T. H. Holland, F.R.S., has been appointed a Knight Commander of the Order of the Indian Empire (K.C.I.E.), Dr. A. G. Bourne, F.R.S., a Companion of the same Order (C.I.E.), and Dr. W. F. King, chief astronomer, Department of the Interior, Canada, a Companion of the Order of St. Michael and St. George (C.M.G.). Dr. Henry Jackson, regius professor of Greek, Cambridge, is appointed to the Order of Merit, which was designed "to include British subjects who have won conspicuous distinction in the naval and military services, or in letters, art, and science." Perhaps Prof. Jackson's claims to this honour may be understood at Cambridge.

Some reference has been made in the daily papers to the ratio of honours awarded to naval and military men, the suggestion being that the Army receives an undue share of these distinctions. With the demands of the two services for recognition we are not concerned, but the question induces us to ask what ratio exists between the award of honours to men who devote their lives to work which promotes the scientific progress of the country and those who do not? As to the relative value to the nation of scientific and party-political work there can be no two opinions; and statesmen themselves, especially when out of office, are ever ready to acknowledge the important part which scientific knowledge plays in national greatness and development. Judging from their utterances, science should be cherished above all things by the nation which desires to secure advancement; but while it is thus honoured in the abstract, it gives place to party politics when rewards for national service are being distributed. Probably the reason is that the ministers and officials who are chiefly concerned with the affairs of State and Court live in a world in which science and the results of science are almost unknown. This is really the characteristic of the official mind in England. For instance, the Court newsman in his official report of the King's garden-party states that invitations were issued to "representatives of the musical, dramatic, and literary professions." It is a striking illustration of the state of the official mind that representatives of the musical and dramatic professions should be referred to as having been invited to meet their Majesties, while science was not mentioned.

As we went to press yesterday, July 1, the Linnean Society celebrated the fiftieth anniversary of the reading of the joint paper on natural selection by Charles Darwin and Alfred Russel Wallace. At the afternoon meeting a medal, specially struck for the occasion, was presented to Dr. Alfred Russel Wallace, Sir Joseph Dalton Hooker, Prof. Ernst Haeckel, Prof. Eduard Strasburger, Prof. August Weismann, Dr. Francis Galton, and Sir E. Ray Lankester. At the same meeting congratulatory addresses were received from British universities and British and foreign societies and academies. About a hundred of the fellows and guests of the society dined together at the Princes' Restaurant at 6.30, and later in the evening a reception was held at the rooms of the society. We hope to give a full account of the proceedings in our next issue.

M. Henri Becquerel has been elected permanent secretary of the Paris Academy of Sciences for the physical sciences.

Prof. H. H. Turner, F.R.S., has been elected correspondant of the Paris Academy of Sciences in the section of astronomy in succession to the late Prof. Vogel.

The death is announced, at Paris, of Dr. Luiz Cruls, director of the Observatory of Rio de Janeiro.

The annual exhibition of antiquities, from excavations in Upper Egypt during the past season, was opened at the Institute of Archæology, University of Liverpool, on Monday, June 29, and will remain open until Thursday, July 9.

THE Physico-medical Society of Vienna has made the following appointments in connection with the celebration of the centenary of the foundation of the society:—*Honorary Ph.D.*, Sir Victor Horsley, F.R.S.; *corresponding members*, Prof. J. Loeb, Dr. C. S. Minot, Prof. E. Rutherford, F.R.S., and Prof. C. S. Sherrington, F.R.S.

THE council of the Royal Society of Edinburgh has awarded the Neill prize for the triennial period 1904–7 to Mr. Frank J. Cole, lecturer on zoology, University College, Reading, for his papers entitled "A Monograph on the General Morphology of the Myxinoid Fishes, based on a Study of Myxine," published in the Transactions of the society, regard being also paid to Mr. Cole's other valuable contributions to the anatomy and morphology of fishes.

ON July 2, 3, and 4 there will be on exhibition at the Royal College of Surgeons, Lincoln's Inn Fields, W.C., a very remarkable collection of specimens illustrating the diseases, injuries, and racial peculiarities of the ancient inhabitants of Nubia. The collection was made during the archæological survey of the area which will be submerged on raising the level of the Aswan dam. The collection embraces specimens derived from cemeteries, to which Dr. G. A. Reisner has assigned dates ranging from a pre-dynastic to an early Christian period. The collection has been described and arranged under the direction of Prof. Elliot Smith, F.R.S., and Dr. Wood Jones. A report of the first results of the archæological survey of Nubia was recently published (Bulletin No. 1, Cairo, 1908), with an introduction by Captain H. G. Lyons, F.R.S.

THE fifth congress of the International Association for Testing Materials is to be held at the beginning of September, 1909, in Copenhagen, when numerous questions in connection with the testing of metals, hydraulic cements, and miscellaneous materials will be considered, and many other important technical problems will be discussed. To maintain closer contact with the members of the association in the intervals between the congresses, the council has decided to publish from time to time Proceedings of the association. Two numbers have appeared already, and the new periodical will certainly keep members informed of what is being done in the subject in which they are interested. Copies of the Proceedings may be obtained in this country from Messrs. E. and F. Spon. The price of each issue is, to non-members, sixpence.

To mark the completion of the fiftieth year of the existence of the Geologists' Association in November next, it is proposed to issue a volume dealing with the geology of the districts of England and Wales visited by the association since its foundation. The volume will consist of a series of articles by competent authorities on the various localities visited, who will deal with the geology of their district from the point of view of present-day knowledge. The book will be edited by Messrs. H. W. Monckton and R. S. Herries, be illustrated with maps and sections, and probably be ready for publication before the end of the year. We notice that the next long excursion of the association is to be to the Berwyns, from July 31 to August 7, under the directorship of Mr. J. Lomas. The headquarters of the party will be at the Wynnstay Hotel, Oswestry, and persons wishing to take part in the excursion are requested to write to Mr. H. Kidner, excursion secretary, 78 Gladstone Road, Watford.

WE learn from *Science* that an expedition, under the combined auspices of the American Museum of Natural History and the Geological Survey of Canada, is now on its way to the mouth of the Mackenzie River and adjacent country to collect ethnological and zoological material. The party is being conducted by Mr. V. Stefánsson, who is well acquainted with the Eskimos of the region, having wintered with them in 1906, and Mr. R. M. Anderson, a well-known naturalist. The expedition was organised for the purpose of making scientific studies of the Eskimos of the country, of procuring collections illustrating, not only the material cultures of the uncivilised tribes of the region, but also of the zoological conditions which prevail there, and of increasing our knowledge of the geology of the region. The expedition will commence its return journey during the summer of 1909.

THE annual general meeting of the Royal Society of Arts was held on June 24, Sir Steuart Colvin Bayley, K.C.S.I., chairman of council, in the chair. The business of the meeting was the reading the report of the council on the work of the society during the past session, the 154th since the formation of the society in 1754. In referring to the award of the Albert medal to Sir James Dewar for his low-temperature investigations, special stress was laid on the power placed at the disposal of those interested in industrial applications of science by the provision of temperatures so far below any hitherto available, and it was suggested that before long this new power would find numerous practical applications. Amongst the lectures delivered under the various trusts available for such purposes, the course of lectures on industrial hygiene, provided out of funds left some years ago to the society by Mr. Benjamin Shaw, was one of the most important. The award of a medal, under the same trust, to Prof. W. Galloway, for his researches into the action of coal dust in colliery explosions, was also recorded.

THE third international congress on the history of religions will be held at Oxford from September 15–18 next. Prof. E. B. Tylor, F.R.S., is the honorary president, Sir A. C. Lyall the president, and Prof. Percy Gardner the chairman of the local committee. The business of the congress will be conducted in nine sections, and there will be general meetings for papers and lectures of wide importance, as well as meetings of sections. In addition to the addresses by the president and by the presidents of sections, numerous important papers will be read. Among these may be mentioned that of Dr. A. J. Evans, on Cretan religions; M. E. Fourrière, on "le culte du soleil et les sacrifices humains chez les Grecs"; Miss Mary A. Owen, on the Messiah beliefs of the American Indians; Prof. A. H. Sayce, on the influence of Babylonian religion upon Asia Minor and Syria; Mr. W. W. Skeat, concerning Malay religion; and Dr. E. Wallis Budge, on some central African elements in the dynastic religion of Egypt. English, French, German, and Italian will be recognised as official languages. Representatives have been appointed already from many British and foreign universities and learned societies. Offers of papers should be sent to the honorary secretaries, Dr. J. Estlin Carpenter, 109 Banbury Road, Oxford, and Dr. L. R. Farnell, 191 Woodstock Road, Oxford.

THE report of the Rugby School Natural History Society for 1907 appears in an abbreviated form owing to the omission of the reports of the papers read, which are issued in a local journal. Steps have been taken during the year to bring the observing station up to the requirements of the Meteorological Office, and it is hoped that when the next report appears the station will have been re-accorded official recognition.

The contents of the May number of the *Victorian Naturalist* include several papers on the local bird-fauna, one of these being illustrated with an excellent reproduction of a photograph of a black-winged gannet colony. In the course of the same paper it is mentioned that the eggs of the short-tailed petrel, or "mutton-bird" (*Puffinus tenuirostris*), are extensively used as an article of diet by the islanders in Bass Strait, and are of excellent flavour.

The second fasciculus of vol. xxxvii. of *Travaux de la Soc. Imp. des Naturalistes de St. Pétersbourg* is devoted to the (mainly invertebrate) fauna of Turkestan, sections of which are described by specialists. An amphipod from the Issik Kul is made the type of a genus under the somewhat barbarous title of Issykogamarus. Of more general interest is an illustrated account, by Mr. V. A. Faussek, on the minatory attitude assumed by the Russian tarantula (*Trochosa singoriensis*), forming part of a paper on threatening postures in animals generally. The spider in question, which has a dark-coloured body with limbs marked by bold bands of black and yellow, is represented in a coloured plate both in its normal posture and in the threatening attitude, when the body is raised nearly vertically with the limbs extended in a radiating manner.

Four out of the five articles forming the combined first and second parts of vol. xxxviii. of the *Morphologisches Jahrbuch* are devoted to the anatomy of mammals, and of these four three relate to the hind-limb. The longest, and perhaps most important, is a paper by Mr. E. Loth, of Warsaw, on the morphology of the plantar aponeurosis in the Primates, in the course of which it is shown that the different types displayed by this structure accord well in the matter of their inter-relationships with the generally accepted classification of the order. In the second paper Mr. E. Glaesmer discusses the flexor muscles of the lower part of the leg and foot, while in the third Mr. G. P. Frets records the variations observable in the peroneal muscles. The sulci in the brain of the cat, and their individual variation, form the subject of the fourth paper, by Mr. E. Landau, of Dorpat, a large number of examples of the brain being figured.

Among several papers published in various Argentine journals, of which we have received separate copies from the author, Prof. Angel Gallardo, special attention may be directed to one published in vol. xvi. of the *Anales* of the National Museum of Buenos Aires on a remarkable case of mimicry in a caterpillar. The caterpillar, which is rather more than 4 inches in length, is the larva of *Dilophonota lassauxi*, and feeds on *Araujia sericifera*, to the stem and leaves of which it presents a most striking resemblance, both as regards form and colouring, as is shown by a coloured illustration. Pale blue in colour, with three longitudinal stripes of fawn, this caterpillar has two of the anterior segments of the thorax transversely enlarged in such a manner that they closely simulate the nodes of the food-plant. The most remarkable feature in the resemblance is, however, the development of a pair of white knobs on the second of these enlarged rings exactly matching the white knobs on the nodes of the plant, which mark the points of attachment of fallen leaves. The mimicry is one of the most remarkable that has ever come under our notice.

An important contribution to embryology is made by Mr. B. M. Davis in his account of the early life-history of *Dolichoglossus pusillus* (a relative of Balanoglossus, and therefore a representative of the Enteropneusta), issued as vol. iv., No. 3, of the Zoological Publications of California University. The creature, which is of a brilliant orange colour, burrows in the mud on various parts of the Californian coasts, and deposits its eggs on one side of the burrow, as is shown in a coloured plate accompanying the memoir. Its breeding-places at San Pedro were recently destroyed, but the author of the paper was fortunate enough to obtain specimens of the eggs at San Diego Bay. The acquisition of these was of the greatest importance, since the only accounts—by Dr. W. Bateson—of the development of the Enteropneusta previously published are incomplete so far as the early stages are concerned. It will be remembered that certain points of resemblance between Balanoglossus and the lancelet were indicated by Dr. Bateson, and from these resemblances it has been argued that the body-cavities of these two organisms have a similar origin. Certain difficulties have, however, been expressed with regard to the acceptance of this view, and the author of the present paper points out that, if his own interpretations be correct, these difficulties are now converted into impossibilities.

According to a note in the Journal of the Royal Society of Arts, the people of Baltimore seem to have been successful in their warfare with the mosquito. In December, 1906, an ordinance was passed by the City Council, and the sum of 2000*l.* appropriated by it, for the purpose of taking measures to exterminate the insect. The first step taken was a distribution by the police to householders of a notice setting forth the provisions of the law requiring all the cisterns, tanks, and wells to be covered with wire gauze; all pools, ponds, fountains, or other water receptacles not containing fish to be screened or covered with crude petroleum; forbidding any water to remain in any receptacle whatsoever; requiring all privy walls to be covered thoroughly with kerosene every fifteen days; and that water be turned off, and water receptacles emptied, should a house be unoccupied for more than five days. Dr. C. M. Hill, who had charge of the work, brought the matter forcibly before the public by delivering lectures explaining the mode of mosquito extermination, and cards were displayed in the tramcars directing the attention of householders to the importance of their cooperation in the work. Reporting upon the experiment, Mr. Consul Fraser says the result of it is satisfactory, and the City Council has appropriated another 1000*l.* for continuance of the work in 1908. The mosquito has hitherto been the cause of much illness and death in Baltimore.

Information regarding another new rubber plant is collated by Dr. O. Stapf in the *Kew Bulletin* (No. 5). The plant, discovered in Portuguese West Africa, receives the name of *Raphionacme utilis*—Raphionacme being a genus of the order Asclepiadaceæ—and is known in the country of origin as "ecanda" or "marianga." It is peculiar in producing a short herbaceous stem, while the latex is obtained from the tuberous root, that may attain a diameter of 5 inches. There is at present no prospect of extracting the rubber with profit.

Although there has been a notable introduction of new species of Primula within recent years from western China, an additional list, remarkable not only for the number of species, but also for the striking characters of certain of the plants, is chronicled by Mr. Forrest in the Notes from the Royal Botanic Gardens, Edinburgh (April). The species of Primulaceæ there described were collected in western Yunnan and eastern Tibet; they include fifteen new species of the genus, also a few species of Androsace and

Lysimachia. The species Littoniana, falling in the section Capitatæ, produces a deep spike of crowded flowers, in which the red calyces of the buds form a strong contrast to the deep purple expanded flowers. *Primula Forrestii* bears numerous flowers of a deep orange colour, and, judging from the root-stocks, continues to grow for fifty years or longer. Three of the four known species of the unique section Omphalogramma—taking their name from the oval, flattened shape of the seed—are recorded. The list is distinctly one that horticulturists will do well to examine.

The heredity of hair in man forms the subject of an article by Gertrude and Charles Davenport in the May issue of the *American Naturalist*. Starting with the assumption that the straight, cylindrical (Mongolian) type of hair, as agreeing with that of mammals generally, is more primitive than the frizzly, compressed type characteristic of negroes, the authors discuss the Mendelian relations of these and the intermediate wavy and curly types. The results suggest that straight hair is recessive to the frizzly type, although the latter may in some instances fail to dominate. Further, wavy hair is usually, if not invariably, a heterozygous type, and not recessive to a higher (curly) and dominant over a lower (straight) stage. The paper concludes with a summary of the colour of the eyes and hair in the children of parents who are similar or dissimilar in these respects.

In the June number of *Man* Prof. Dubois discusses Mr. J. Gray's investigations on pigmentation by the use of his newly modified Lovibond's tintometer. He accepts the suggestion that hair contains two coloured pigments, orange and black, the black pigment increasing uniformly in amount from blonde to black, the orange pigment remaining practically constant in that hair series. In the red-hair group, on the contrary, the orange pigment is predominant, its increasing amount causing the coloration from light to dark red. Finally, red hair is derived from dark hair by the conversion of more or less of the dark pigment into an equal amount of the orange. This last group, for which he suggests the name pyrrhotism (*pyrrhos* = foxy-red), he considers to result from an easily occurring chemical modification of the melanochrome into pyrrhochrome pigments. But the observed facts are inconsistent with the view of Topinard and others, that red-hairedness may be regarded as having the character of a variety of atavistic origin.

In a short article published in Nature last March (vol. lxxvii., p. 465), attention was directed to the interesting results in reference to the chemistry of Egyptian mummies which had been elucidated by the recent work of Dr. W. A. Schmidt. His conclusions, however, do not seem to have met with universal acceptance, and Mr. F. Lucas has in particular questioned one of them (*Cairo Scientific Journal*, vol. ii., April), namely, that relating to the composition of the bath in which the ancient dead were soaked. According to Schmidt, the "natrum" bath of Herodotus consisted mainly of common salt, and not of "natrum" or crude Egyptian sodium carbonate, which is found encrusted on the bottom and sides of certain lakes in the land of the Pharaohs; if natrum was used at all, it was employed for stuffing the mummy after the pickling bath of brine. Mr. Lucas believes, on the other hand, that "natrum" was actually used in the bath, though in some cases it was applied in solid form, and that the use of common salt was not introduced until the beginning of the Christian era.

Mrs. Andrew Johnson sends us a diagram of a curious ring around the moon observed by her at Arundel on June 11, at 10 p.m., that is, three days before full moon. The ring was not a complete circle, but segment-shaped, corresponding to the phase of the moon at the time. Two mock moons seen respectively to the east and west of the moon itself, and a second halo touching the chord of the segment, were also similarly shaped. The diagram is unsuitable for reproduction, but the distortion of the halo and mock-moons represented by it is of noteworthy interest.

The results of the meteorological observations on the summit of the Sonnblick (3105 metres) for the year 1907 give the mean temperature of January as 4°·6 F., of July as 30°·2; the absolute maximum was 49°·5, in August, and the minimum −18°·2, in January. The precipitation was equivalent to 65·8 inches, in 241 days, of which 5·6 inches fell as rain between May and September. Fog was observed every month, the total number of days being 262; it was least frequent in November, eleven days. The report contains particulars of several other mountain stations, including an interesting account of the Etna Observatory (2950 metres), with a photographic illustration of the volcano as seen from Catania.

Among the various useful articles in the Journal of the Meteorological Society of Japan for January–April (abstracts of which are now given in English), we may mention:—(1) relation between climate and tobacco cultivation, by K. Asakura, and (2) climate and rice crops, by H. Ogiwara, containing interesting particulars of the influence of rainfall and temperature on different stages of the growth of these crops; (3) a summary of the temperature and rainfall observations made during the last three years at stations in south China, by M. Ishida. The tables show that the climate there is not far different from that of the western part of Japan, except that the absolute maximum temperature in south China is more extreme, reaching at times 102°. The Yang-tse-kiang has a great influence in moderating the continental climate. Particulars are given in the April number of the journal of a new system of storm signals introduced in Japan on April 1, showing, during the day time, by means of drums, cones, and balls, the position of the storm centre, its direction of motion, speed, and other details. During the night time lights are displayed, indicating only the position of the storm centre.

The Sierra Club Bulletin (January) contains an article by Mr. G. K. Gilbert on "Lake Ramparts." Special attention is directed to the lake ramparts in the sierra of southern Utah, and the influence of glacial action in their formation is discussed. The absence of ramparts in the lake basins forms the basis of the theory that some force has been exerted to move the boulders to their present positions on the shores. The nature of this moving agency is discussed, the suggestion that the work was carried out by aboriginal inhabitants of the country being dismissed as improbable. The theory which adopts ice as the moving force is supported by the fact that ramparts are found only in cold countries. Mr. Gilbert illustrates this theory by means of sections of sheet-ice, showing modes of cracking and the effects of thrust on the shores, and explains how this action may have transferred the boulders from the lake basins to the shores.

The Berlin Gesellschaft für Erdkunde has issued a bibliography of geographical literature published during the year 1904, compiled by Dr. Otto Baschin, and published under the title of "Bibliotheca Geographica" by Mr. W. H. Kühl, of Berlin. The works are arranged according to subjects included under the two main divisions of general geography and special geography, the latter being subdivided under headings dealing with different countries. In the various subdivisions the works dealt with are classified under the names of the authors, and include publications in several languages.

In an article in the *Cairo Scientific Journal* for March Captain H. G. Lyons, F.R.S., deals with "Some Unsolved Problems of the Nile Basin." Exploration in this region by geographical pioneers has extended our knowledge of its main features, but detailed surveying is needed, especially on the northern margin of the equatorial plateau and of the Abyssinian tableland. In the field of geology Captain Lyons gives a sketch of the history of the Nile Valley, and comments on the secular rise of the lower valley and its future effects on Middle Egypt. Observations are required of the underground water table, its seasonal movement, and level with reference to the river. No definite information can be obtained of the coal or other minerals of commercial value until the early geological history of north-east Africa is better known. The great meteorological problem to be solved is that of the monsoon rains of Abyssinia and the Sudan. The development of rains in equatorial regions, snowfall on the Himalayas, and high-pressure conditions in North Africa are some of the influences to be studied as possibly affecting the Abyssinian rains. Historically, the question of the change of climate in North Africa is of great interest, although other causes should be considered simultaneously in accounting for the decay of the flourishing settlements which once existed in this region. Referring to the oases of North Africa, Captain Lyons reviews briefly the evidence of underground water in the desert, and states the problems of its supply and connection with the Nile.

A good illustration of the power of the weapon which the discovery of the Röntgen rays has placed in the hands of the medical profession is afforded by an article entitled "A Study of Constipation by Means of the X-rays," by Dr. A. F. Hertz, of Guy's Hospital, which appears in the June number of the *Archives of the Röntgen Ray*. After a dose of a bismuth salt has been administered to a patient it is possible to follow by Röntgen-ray photography the passage of the food through the œsophagus, stomach, and intestines, and thus determine the position, and in some cases the nature, of any obstruction which may be present.

The *Physikalische Zeitschrift* for June 15 contains a translation of a paper by Mr. O. M. Corbino, of the University of Messina, on an arrangement for producing almost constant direct currents of high potential. It consists of an induction coil capable of giving a spark of a few centimetres the primary current of which is supplied through a Wehnelt interruptor having a very small anode. The secondary is connected to the terminals of a condenser of a few micro-farads capacity which has a resistance of about 20,000 ohms in parallel with it. Between one terminal of the coil and the corresponding terminal of the condenser a spark gap of 2 mm. is inserted. In these circumstances a direct current of about 30 milliamperes flows through the 20,000 ohms, and its magnitude seems to be little influenced by change of value of the resistance.

We have received a copy of a new quarterly journal published by the Institution of the Post Office Electrical Engineers, and entitled the *Post Office Electrical Engineers' Journal*. The new journal is chiefly devoted to technical matters of interest to Post Office engineers, the articles in the first number dealing with various telegraphic and telephonic subjects. Doubtless sufficient scope exists for such a paper amongst the large staff engaged at home and in the colonies, and if future numbers fulfil the promise of the first, it should go a long way to promote the spirit of fellowship and feeling of common interest which is one of the main reasons for its inception. It is to be hoped the editors will not be led to step outside the legitimate limits of such a more or less private journal by attempting to make it the receptacle for much original research, and thus adding one more to the already excessive number of journals which the electrical engineer must consult. The lighter and social sides also find adequate treatment in the present number, the contributions being in both prose and verse. We wish the new publication all success.

A well-known experiment in physics is to freeze water by placing under the receiver of an air-pump some water in a shallow dish supported above a large dish containing sulphuric acid. Upon exhausting the receiver, evaporation rapidly takes place and the vapour is absorbed by the acid, with the result that the temperature of the water may be reduced to freezing point. We have recently had an opportunity of seeing the Raplin Hand Ice Machine, made by the Pulsometer Engineering Co., in which this principle is put to commercial use. The apparatus consists of a large bottle containing the sulphuric acid, and connected with the air-pump and a carafe or an ice-mould by means of pipes. A wheel turned by hand serves to actuate the pump, which reduces the pressure and also rocks the acid-container, so that the acid is splashed thoroughly and the absorption of the vapour by it is thus facilitated. In three or four minutes a carafe of ice-cold water can be produced, and a block of ice weighing about 1 lb. in twenty minutes. Half a gallon of acid constitutes a complete charge, and will serve to cool from fifty to one hundred carafes of water to freezing. The machine provides an interesting and handy means of reducing temperature by rapid evaporation.

The Select Committee of the House of Commons on the question of proposed daylight saving legislation has now completed its inquiry, and agreed upon its report. The report is understood to be favourable to the principle of the Bill introduced earlier in the session on the subject by Mr. Robert Pearce. The committee is in favour of the introduction of a Bill to achieve the object in view by an alteration of clocks to the extent of one hour at 2 a.m. on the third Sunday in April and by an hour's alteration in the opposite direction on the morning of the third Sunday in September.

A very useful classified list of Smithsonian publications available for distribution has been published by the Smithsonian Institution of Washington. The volumes and pamphlets are arranged conveniently according to subjects. Applicants for these publications must state the ground of their requests, as the institution is able to supply papers only as an aid to the research or study in which the applicant is especially interested. The volumes of contributions and of miscellaneous collections are distributed only to public libraries and to learned societies. Unfortunately, we have no agency in this country which is in a position to aid the spread of scientific knowledge in a similar way and on the same generous scale as the Smithsonian Institution.

## *OUR ASTRONOMICAL COLUMN.*

ASTRONOMICAL OCCURRENCES IN JULY:—

July 4. Opposition of Juno.
7. Uranus in opposition to the Sun.
,, Saturn. Outer minor axis of outer ring $=5''\cdot68$.
9. 12h. 57m. Minimum of Algol ($\beta$ Persei).
12. 9h. 46m. ,, ,, ,,
16. 10h. 59m. to 12h. 3m. Moon occults $\tau^2$ Aquarii (mag. 4·3).
18. 16h. 11m. Saturn in conjunction with Moon. Saturn 3° 2′ N.
22. 16h. 35m. Western elongation of Saturn's Satellite Titan.
25. 10h. Mercury at greatest elongation, 19° 50′ W.
27–31. Epoch of the Aquarid and early-Perseid meteors.
29. 15h. Vesta 0° 1′ S. of Moon.
,, Venus. Illuminated portion of the disc $=0\cdot153$.
30. 16h. Eastern elongation of Saturn's Satellite Titan.

A BRIGHT METEOR.—A magnificent meteor, with a long path and very slow motion, was observed on June 28 11h. 12m. by Mr. Denning at Bristol, and by the Rev. John Brown at Brighton. At Bristol, the apparent course was recorded as from $276°+23°$ to $1°+48\frac{1}{2}°$, while at Brighton the object passed just under the stars $\beta$ and $\gamma$ of Ursa Major, and just above Cor Caroli, the direction being from $\beta$ Scorpii.

Mr. Denning has investigated the real path, and found the heights eighty-seven to fifty-four miles over Dorchester, Dorset, to Kineton, Warwick. Length of observed flight 123 miles, and velocity $17\frac{1}{2}$ miles per second. Radiant point $240°-20°$, and about 10° W. of the usual radiant of the June shower of Scorpiid fireballs. The meteor had a bright train of sparks, and sailed along a considerable arc (70°), the duration at Bristol being estimated as seven seconds and at Brighton six to eight seconds.

COMPUTED MAGNITUDES FOR HALLEY'S COMET BEFORE PERIHELION.—In No. 4254 of the *Astronomische Nachrichten* (p. 99, June 13) Prof. J. Holetschek discusses the probable magnitudes of Halley's comet during the two oppositions which are to come before it arrives at perihelion. Monthly ephemerides show the probable positions of the comet for October, 1908, to March, 1909, according to the assumptions that perihelion passage will take place on May 16, 1910, thirty days earlier or thirty days later, and the geocentric and heliocentric distances are also shown. Then follows the table giving the probable magnitudes for the same period, and also for September and October, 1909. From this we see that for October 2, 1908, the probable magnitude is 18·2, the comet increasing in brightness until, on October 2, 1909, its magnitude should be 14·6.

THE REVISED HARVARD PHOTOMETRY.—We have just received a copy of vol. l. of the Annals of the Astronomical Observatory of Harvard College, in which is published the revised Harvard photometry. This comprises a catalogue of the positions, photometric magnitudes, and spectra of the 9110 stars, mainly of magnitude 6·50 and brighter, which were observed with the 2-inch and 4-inch meridian photometers, in all parts of the sky, during the years 1879 to 1906. Some idea of the magnitude of the work may be gathered from the fact that the observations involved a total number of 1,082,060 photometric settings. In the catalogue itself the stars are given consecutive numbers, and are arranged in order of R.A. as usual. Then follows the designation for each star in other catalogues, the position for 1900, the magnitude, the residuals, and the combination of letters and figures which denotes the spectral type. It is proposed by Prof. Pickering that the abbreviation H.R. shall be used when referring to a star's designation in the present catalogue. Several pages of "remarks" which follow the catalogue proper give valuable notes concerning stars which are in any way peculiar.

THE PARALLAXES OF NEBULÆ.—From a re-discussion of Prof. Wilsing's results for the parallaxes of the two nebulæ G.C. 4964 and N.G.C. 7027, Herr Einar Huss, of Stockholm, derives new definitive values which, in each case, show a reduction of the negative values obtained by Prof. Wilsing. For G.C. 4964 the latter observer found the parallax $-0''\cdot083\pm0''\cdot025$, whereas Herr Huss derives the value $-0''\cdot063\pm0''\cdot050$; for N.G.C. 7027 the respective values are $-0''\cdot172\pm0''\cdot068$ and $-0''\cdot110\pm0''\cdot021$. Taking into account the facts that the observations were made at about the same epoch, and that the objects are in the same part of the sky, Herr Huss considers that there is evidence that, of the two, the nebula N.G.C. 7027 is the more remote (*Astronomische Nachrichten*, No. 4254, p. 96).

OCCULTATION OF JUPITER'S SATELLITE II. BY SATELLITE I. In No. 4255 of the *Astronomische Nachrichten* (p. 110, June 18) Prof. Hartmann places on record the results obtained from observations of the occultation of J. ii. by J. i. on February 24. The observations were made with the 50 cm. refractor of the Potsdam Observatory, a power of 450 being used, and the best value for the time of the middle of the conjunction is given as 9h. 45m. 32s. ± 5s. (M.E.T.).

SOLAR PROMINENCES IN 1907.—Prof. Riccò's summary of the results of the prominence observations made at the Catania Observatory during 1907 appears in No. 5, vol. xxxvii. (p. 83), of the *Memorie della Societa degli Spettroscopisti Italiani*; the usual data regarding the latitudes, heights, and extensions at the base are given, and the complete results summarised. The mean heliographic latitude, for both hemispheres, was 29°·4, being 1° less than in 1906; a notable maximum occurred in the third quarter in latitude 80°–85° south. In the northern hemisphere, for the whole year, there were two well-defined maxima (in latitudes 50°–60° and 20°–30°), and in the southern hemisphere there were three (latitudes 10°–20°, 40°–50°, and 80°–90°). During the first five months the number of prominences in the northern hemisphere preponderated, but for the last seven months the southern hemisphere showed the greater numbers; the numbers observed for the whole year were 381 and 447 respectively.

THE TEMPERATURE AND STRUCTURE OF THE SUN.—In a lecture delivered before the Philosophical Society of Washington, and now printed as a bulletin of the society (vol. xv., pp. 75–101, May), Dr. O. Lummer gave an interesting and suggestive *résumé* of our present knowledge concerning the probable temperature and structure of the sun. From a discussion of the laws of radiation as applied to the observed solar values, he arrives at the conclusion that the temperature may, with reasonable certainty, be assumed to be about 7000°. As such a temperature surpasses the critical temperature of all terrestrial substances, Dr. Lummer concludes that a sharp limit between a liquid and a gaseous mass on the sun is physically impossible. On the basis of this conclusion he discusses the probable structure of the sun's envelopes, and finds that most of the spectral phenomena observed, *e.g.* the broadening of lines in sun-spots and the distortion and displacement of various lines in prominences, can be accounted for by the assumption that they are produced by anomalous dispersion in the various layers of the sun's atmosphere.

## *THE ROYAL SOCIETY CONVERSAZIONE.*

THE annual conversazione to which ladies as well as gentlemen are invited by the Royal Society was held in the society's rooms at Burlington House on Monday. Most of the objects of scientific interest exhibited on this occasion were the same as those shown at the conversazione in May, and already described in these columns (May 21, p. 58). A few additional exhibits may, however, be referred to here to supplement the previous article. As before, we summarise the descriptions in the official catalogue, after arranging together related subjects.

*Dr. George E. Hale and Mr. Ferdinand Ellerman:* Astrophysical photographs taken at Mount Wilson Solar Observatory, Pasadena, California.—*The Director of the Meteorological Office:* Zoetropic apparatus exhibiting the progress of a travelling storm-centre and the circulation of air associated therewith. By means of a series of maps, upon which the isobaric lines and corresponding steps of the trajectories are drawn, and an ordinary zoetropic apparatus, viz. a revolving drum with slits through which the succession of maps is seen, the spectator is enabled to see both processes in progress, viz. the march of the depression and the course of the air in the various parts of the depression.—*Mrs. Hertha Ayrton:* The residual motion of water moving in stationary waves. When a liquid rises and falls in rhythmical wave motion its particles do not simply swing to and fro, returning, like pendulums, to their starting points after each oscillation, but each particle takes up a new position after each oscillation, so that it traces out a path for itself, only returning after many oscillations to the point from which it started. This general movement, which takes place in conjunction with the oscillatory movement, is called the residual motion of the liquid. It takes the form of vortices of peculiar shape, which are exactly the opposite of the ripple-forming vortices to which obstacles under the water give rise, since a single residual vortex is only completed in many oscillations, while each ripple-forming vortex is born and dies in a single swing.

*Prof. A. M. Worthington, C.B., F.R.S.:* Recent instantaneous photographs of splashes.—*Dr. W. J. Russell, F.R.S., and Mr. O. F. Bloch:* Photographs of flowers, &c., in natural colours (Lumière process).—*Mr. H. G. King and Mr. R. Kerr:* "Master gauges" or "standards" for extremely accurate measurements, the invention of Mr. C. E. Johansson, of Sweden. By using these gauges separately or combined together, more than 80,000 different sizes can be obtained, any of which sizes are accurate to within 0·00004 inch at 66° F. The steel is so treated as to reduce to a minimum any chance of change after being hardened. The gauges are used where extreme accuracy is required, as in the manufacture of machine parts, tools, and various instruments; also for "marking off" dies on surface plates and for testing them when machined, &c. Two of these blocks put face to face can sustain a pull of $11\frac{3}{4}$ lb., or 22 lb. to the square inch.—*Mr. Frederick Iles:* (1) "Irisographs," or chemical designs. "Irisography" is a method of producing coloured designs by means of chemical solutions applied in spots upon unsized paper, and subsequently developed by the central application of a compound solution which, spreading by capillary attraction, and coming into contact with the previously applied spots, combines with and reacts upon them to produce designs of varied outlines and colours. (2) "Caleidographs." Original designs executed by aid of the caleidograph on china, glass, paper, and on prepared glass plates. The "caleidograph" is an instrument to facilitate the working out or elaboration of simple or complex designs composed of geometrical curves and lines, either upon paper or on the actual articles of china, glass, metal, &c.

*Dr. J. A. Fleming, F.R.S.:* Transmission of signals by electromagnetic induction between oscillatory circuits, and their reception by means of a glow-lamp detector. At one end of the principal library a square circuit was set up in which high-frequency oscillations were created by the discharge of a Leyden jar charged by an induction coil. The coil was actuated by a coal-gas mercury break, and the spark was in a silencing chamber with air-blast arc destroyer. The oscillations were cut up into Morse signals by a punched tape and relay in the primary circuit. One hundred feet away was a similar receiving circuit, in which oscillations were created by induction transmitted from the sender, and were detected by a glow-lamp detector or oscillation valve and telephone. Messages and signals thus sent formed a small-scale exhibition of high-frequency inductive wireless telegraphy.—*Dr. Alexander Muirhead, F.R.S.:* A combined Kelvin siphon recorder and cable relay. The latest form of the Kelvin siphon recorder has been converted into a successful cable relay by simply substituting fine gold wire for the silk fibre which connects the siphon to the vibrator.

*Mr. Leonard Hill, F.R.S.:* (1) Self-contained diving dress (made by Messrs. Siebe, Gorman and Co., Ltd.). Air-pump, pipe, and life-line are done away with, and the diver is connected to the surface by a telephone cable only. Attached to the back of the ordinary diving dress are cylinders containing air with 50 per cent. oxygen. The oxygen mixture is delivered to the helmet by a pipe, to which a reducing valve is attached. The supply is 4 litres per minute, and lasts two hours. Two caustic soda boxes are connected by a pipe with the helmet, and by a second pipe to an aspirating arrangement placed in the oxygen delivery tube. The force of the oxygen mixture escaping through a narrow jet is used to aspirate the air in the helmet through the soda boxes, which purify it from the exhaled carbonic acid. (2) Life-saving apparatus for use in mines (made by Messrs. Siebe, Gorman and Co., Ltd.). The apparatus, perfected out of that of Mr. Fleuss, consists of a breathing bag, and cylinders of compressed oxygen, carried by straps passing over the shoulders, and so hung that the man is free to do work. The dress allows the man to be stripped to the waist in hot atmospheres.—*Prof. Arthur Gamgee, F.R.S.:* Photographs, drawings, and plans exhibiting the apparatus employed by Prof. Gamgee in his research on methods for the continuous (photographic) and quasi-continuous registration of the diurnal curve of the temperature of the animal body.

*Dr. G. H. Rodman:* A series of stereoscopic radiographs of molluscal shells. Prior to the application of the Röntgen rays to this branch of zoological research, it was necessary to sacrifice the specimen in order to disclose the internal anatomy of the columella and whorls—a course obviously undesirable in the case of a rare and possibly unique shell. In some of the examples shown the radiograph has been so made as to show the equivalent of both horizontal and vertical sections.—*Mr. H. S. Leigh:* Living examples of the leaf insect from the Seychelles, *Phyllium crurifolium*, Serville. The Phylliums afford one of the most striking examples of protective resemblance. The specimens are not only very similar to leaves in shape and colour, but in their peculiar movements imitate the shaking of the leaves. The resemblance to vegetable structures is carried still further, since the eggs bear a marked likeness in shape and colour to certain seeds.—*Prof. J. Cossar Ewart, F.R.S.:* Hybrid between a Prejvalsky mare (*Equus prejvalskii*) and a Highland pony. This is one of six hybrids bred from wild horses imported from Mongolia. With the exception of the one exhibited, the hybrids are out of pony mares. All six hybrids are males, and two foals out of pony mares by a hybrid bred at Penycuik in 1905 are males. The hybrids support the view that a wild horse of the Prejvalsky type took part in the making of domestic horses. Four of the six hybrids were bred at Woburn by his Grace the Duke of Bedford.—*Mr. F. Enock:* Insect intelligence, as exemplified in the life-history of the wood-boring wasps (Crabronidæ). All hymenopterous insects show a high degree of intelligence. One species of Crabro fills its cells with one, and only one, species of insect; another with one kind of beetle; a third with homopterous insects.

*Dr. A. S. Woodward, F.R.S.:* Photographs, by Mrs. E. von Kaufmann, of portions of carcases of a mammoth and rhinoceros found preserved in petroleum at Starunia, Galicia. These specimens were obtained in an ozokerite mine while sinking a shaft through the deposit of an old marsh which was saturated with petroleum.—*The Director-General, Survey Department, Egypt:* Plans, photographs, and objects illustrating the archæological survey of that portion of the Nile Valley which will be submerged by the Aswan reservoir when its level is raised. A detailed survey of the valley and the ancient sites is being made, and the anatomical study of all human remains found is being carried on simultaneously with the archæological investigations. Numerous pre-dynastic cemeteries have been found, and the present evidence shows that in these times Lower Nubia and Egypt formed one ethnological territory, both districts being in the same state of culture. From the first dynasty their history diverges; in Egypt the race remains unchanged, and culture shows a progressive development; in Nubia the race becomes mixed with a strong infusion of negro blood, and culture lags behind that of Egypt.—*Miss M. Helen Tongue:* Bushmen paintings copied by the exhibitor from the caves and rocks in Cape Colony, Orange River Colony, and Basutoland. The paintings, which are found on the walls or roofs of rock shelters or caves, generally in sandstone districts, have been coloured with iron oxides, or with ochres mixed with fat. The date of the work varies. In Cape Colony the latest paintings must be nearly a century old. In Basutoland there may be some of a later date; probably most are older. The pictures have been carefully traced, and the colours and background copied as exactly as possible.

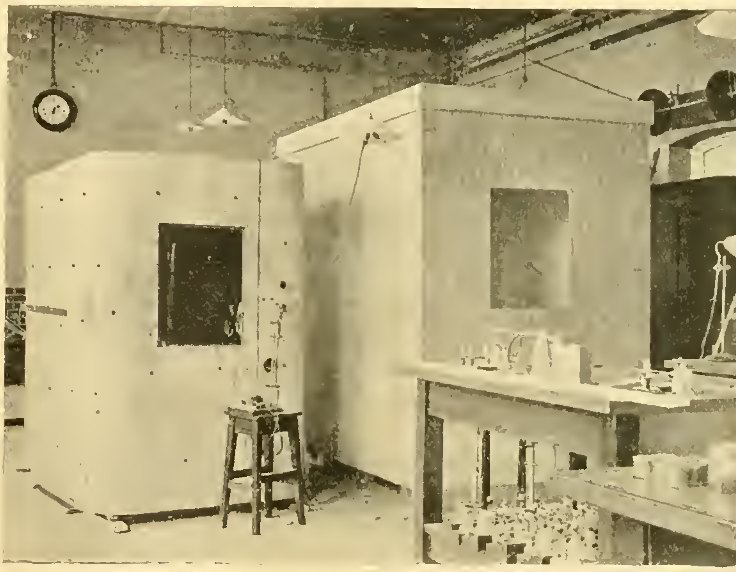
## A CALORIMETER FOR DETERMINING THE RELATION BETWEEN HEAT-PRODUCTION AND MUSCULAR WORK.

IN the physiological laboratory of the University of Sheffield a calorimeter has been erected on the model of Atwater and Benedict's calorimeter, now carried by Prof. Benedict to a great state of perfection in the Nutrition Laboratory at Boston, U.S.A. The Sheffield copy is not at present a complete one, and its limitations are best detailed by a brief description of the problem in the solution of which it is hoped immediately to play some part. This problem is the nature of the physicochemical process underlying the phenomenon of muscular contraction, upon which some work has been in progress in this laboratory already along somewhat different lines.

A precise statement of the relation existing between muscular work and heat production is a necessity for the final solution of this question. Even before precision can be hoped for, additional information may be of much value in deciding the comparative value of different lines of attack. Thus, it having been already shown that the energy liberated is entirely to be assigned to the combustion of food, the question arises as to whether the contraction is the direct consequence of the combustion which takes place at the same time, or as to whether it is not rather the consequence of some preceding combustion. In the latter case there would be nothing remarkable in the proposition that the combustion responsible was in the main an occurrence taking place during a preceding contraction. Each contraction might, so to speak, wind up a spring for release in the next contraction. The usual view is that contraction and the combustion responsible for it are concomitant; the view of the Sheffield laboratory is that they are not. The second point of view can be at once supported by the well-known fact that fatigued muscle is apparently a more economical heat engine than muscle in good condition, giving off less waste heat for an equal amount of external work done. Such a fact loses all peculiarity if it is considered merely as a failure on the part of the fatigued muscle to provide for succeeding contractions. It is in the hope of collecting further data of this kind that the calorimeter has been constructed. The immediate necessities, therefore, are a calorimeter within which prolonged muscular work can be performed, and from which a complete statement of the amount of work done and heat given off can be obtained. Benedict's original instrument offers much more information than this, since it is a complete respiration calorimeter, providing by its use data for a perfect balance-sheet both of chemical material and energy. It is hoped to raise the Sheffield apparatus to the same level of perfection, so that it may be placed at the disposal of investigations of a more general kind when additional financial aid has been obtained.

The calorimeter has been constructed by Messrs. George, of Birmingham, who have followed the detailed instructions provided by Benedict in the publications of the Carnegie Institution, Washington. At one stage of construction it was examined by Prof. Benedict, and then met with his approval. He was kind enough to make important suggestions, which have since been carried out.

A small room, 8 feet by 6 feet by 5 feet, has been built of copper sheets carefully soldered together and stiffened by an external wooden framework, to which they are fixed. On the outer surface of the framework zinc sheets have been fastened, forming a second metal covering. The double-walled metal box so formed rests on rails within a double-walled wooden house enclosing it. Thus the walls, copper, zinc, wood, and wood separate three layers of air external to the chamber. The accessory arrangements of the calorimeter render it possible to maintain the zinc sheath and the two outer layers of air at the same temperature as that of the copper box, whatever that may be. Heat is thus prevented from escaping from the walls of the copper chamber. This end is secured by heating and cooling apparatus in the two outer air spaces, resistance wires and cold-water pipes. The degree to which the heating and cooling mechanism is resorted to in each of these spaces is determined by the observation of electrical currents from one hundred and fifty sets of thermocouples arranged in two series, a series indicating differences of temperature between the copper and zinc sheaths, another indicating differences between the two outer air spaces. Each series is divided into zones, so that the state of the roof, the floor, or each of three zones in the side walls can be separately observed. The heating and cooling mechanism is similarly subdivided. The observer seated outside the calorimeter can rapidly test each segment of the calorimeter in turn, and rapidly balance any difference found by adjustments of rheostats admitting more or less current to the heating wires, and taps admitting more or less water to the cooling pipes.



Calorimeter for physiological experiments at Sheffield University. The metal chamber on the left is now enclosed in the wooden house on the right. The spots on the wall of the metal chamber are tubes in which the thermocouples now lie.

The difficulties in construction up to this point lie mainly in the thermocouples and their fixation. It is a difficult matter especially to prevent risks of short-circuiting and displacement from incapacitating those placed to read differences of temperature between the copper and zin., since the subject within the calorimeter by movements causes awkward bulgings of the metal.

A second difficulty in construction is the necessity for an absolutely air-tight copper chamber admitting no air save through the pipe provided, and allowing none to escape save through the exit tube. There are a number of apertures which have to be carefully sealed. Thus the window through which the subject enters is subsequently glazed. There is also an air lock through which material can be passed into and out of the chamber. This is guarded by a double port. There are also four tubular openings through which pass telephone wires and wires to an electromagnet and to the copper disc of a bicycle ergometer, a cable from the beam of a balance placed above the calorimeter, the entrance and exit tubes of the radiator system of water-pipes, and a lever for adjusting the position of shields covering the radiator system. All these apertures are sealed in various ingenious ways, but none too securely. Doubtless practical experience will both provide and remove fear of defects in this direction. When to this is added the risk introduced by every screw passing through the copper, such as, for example, those necessary for the fixation of the bed, the balance beams from which the radiator system is suspended, &c., there is at present fear enough. It was in indicating points such as this that Prof. Benedict's visit was of so much value.

The heat produced within the copper box, carefully prevented from escaping from its surface in the manner described, is carried out in a stream of water constantly driven through the radiator system. The quantity of water passing is varied with the necessities of the moment, and is necessarily much greater when the subject is at work on the ergometer. The water passing is weighed on exit in a meter, and its temperature on entrance and exit observed. The former is practically constant, the latter kept as constant as possible by variation in the rate of water flow. These data form the main items in the statement of heat produced, though other important items, such as the amount of water condensing on the radiator pipes within the chamber, the water evaporated and carried through with the air leaving the chamber, are duly considered and provided for. Thermocouples are placed in the tubes through which the air finds entrance and exit, in quantity 75 litres per minute, so as to ensure the detection of any difference of temperature. Any difference found is corrected by increased heating of the entering air.

In Benedict's calorimeter the air is driven from the chamber through a closed system of tubes back to the chamber again. In this system are interpolated sulphuric acid and soda lime absorbers of a necessarily very large size, determined by the large mass of air in motion per unit of time. The oxygen consumed is made good by admission of oxygen from a cylinder of the compressed gas. In the Sheffield apparatus this will not, at first at least, be attempted. Dried air heated and passed into the chamber will be driven out through a sulphuric acid absorber, no attempt being made to do more than take a determination of the water.

## *RECENT RESEARCHES IN THE STRUCTURE OF THE UNIVERSE.*[1]

I CONSIDER it an uncommon privilege to lecture on the structure of the universe in the country of the Herschels. Even now their celebrated gauges are unrivalled, and they still form one of the important elements on which any theory of the stellar system must be based. It is well known that the plan of these gauges consisted in directing the telescope successively to different points all over the sky, and simply counting the number of stars visible in the field.

There is one fact clearly brought out by these gauges to which I must direct your attention. It is that in the outward appearance of our nightly sky, as seen with the telescope, there is a great regularity. In the Milky Way, that belt which we see with the naked eye encircling the whole of the firmament nearly along a great circle, the number of stars, as seen in Herschel's 20-feet reflector, is enormous. On both sides this apparent crowding of the stars diminishes very gradually and regularly until, near the poles of the Milky Way, we come to the poorest parts of the sky.

Let us look at this phenomenon somewhat more closely. If we direct our telescope first towards the part of the Milky Way near Sirius, and if from there we gradually work up towards the North Pole of the Milky Way in the constellation called the Hair of Berenice, we shall clearly perceive this gradual and regular change in the number of stars. Now if we repeat the same process, beginning from some other point of the Milky Way, say in Cassiopeia or the Southern Cross, we shall find that, not only is there a similar gradual change, but we shall approximately go through the same changes.

At the *same* distance from the Milky Way we shall find, approximately, the same number of stars in the field of the telescope. Put in other words, the richness of stars varies regularly with the galactic latitude; it varies relatively little with the galactic longitude.

Imitating most of the investigators of the stellar system, we will therefore disregard the longitude and keep in view only the changes with the galactic latitude. In reality this comes to being satisfied with a first approximation. For, in reality, there are differences in the different longitudes, especially in the Milky Way itself. But even here the differences are not so great as seems commonly to be supposed. There is every reason to believe, therefore, that our approximation will be already a tolerably close one.

### *Real Structure.*

Meanwhile, what the Herschel gauges teach us is only relative to the outward appearance of the sky. What is the real structure of the stellar world? If we see so many stars in the field, with the telescope directed to the Milky Way, is it because they are really more closely crowded there, as Struve thinks, or is the view of the older Herschel correct, who imagined that the greater richness is simply a consequence of the fact that we are looking in deeper layers of stars; that our universe is more extensive in the Milky Way than it is in other directions?

Imagine that we could actually travel through space. For instance, imagine that first we travel in the direction of the constellation Cassiopeia. If we travel with the velocity of light, not so very many years would pass before we get near to some star. Proceeding on our journey for many, many more years, always straight on, we will pass more stars by and by. How will these stars look thus viewed from a moderate distance—say, from a distance as that of the sun? Will they all be found to be of equal luminosity, as Struve practically assumed? And in this case are they as luminous as our sun, or more so, or less so? Or are they unequal? If so, how many of them are brighter than our sun, how many fainter? Or, to be more particular, how many per cent. of the stars are 10, 100, 1000, &c., times more luminous than our sun? How many are equal to the sun, or 10, 100 times fainter? In a few words: What is the nature of the mixture? or, lastly, what is the *mixture law* of the system of the stars?

Furthermore, in travelling on, shall we find the stars in reality equally thickly, or rather thinly, crowded everywhere? Or shall we find that after a certain time, which may be many centuries, they begin to thin out, as a first warning of an approaching limit of the system? Is there really such a limit, which, once passed, leads us into abysses of void space?

Herschel thought there was such a limit, and even imagined that his big telescope penetrated to that limit; that is, he assumed that his telescope made even the remotest stars visible. On this supposition is based his celebrated disc theory of the system.

Again, we may condense these questions in this single query: How does the crowding of the stars, or the *star-density*, that is, the number of stars in any determined volume (let us say in a cubic light century), vary with the distance from our solar system?

But there is more. We supposed that our journey went straight on in the direction of Cassiopeia, which is in the Milky Way. What if our journey is directed to the Pleiades, which are at some distance from that belt, or to the Northern Crown, which is still further, or to the Hair of Berenice, which is furthest of all from the Milky Way? For different regions *equally* distant from the galaxy we have seen that outward appearances are the same. We may admit, with much probability, that in space, too, we would find little difference. Summing up, the problem of the structure of the stellar system in a first approximation comes to this:—

*To determine, separately for regions of different galactic latitude, in which way the star-density and the mixture vary with the distance from the solar system.*

I think that there is well-founded hope that, even perhaps within a few years, sufficient materials will be forthcoming which will allow us to attack the problem to this degree of generality, with a fair chance of success. At the present moment, however, our data are yet too scanty for the purpose. Still, they will be sufficient for the derivation of what must be in some sort *average* con-

[1] Discourse delivered at the Royal Institution on Friday, May 22, by Prof. J. C. Kapteyn.

ditions in the system. The method of treatment will not be essentially different from that which will be applied later to the more general problem, but we have provisionally to be content with introducing the two following simplifications :—

(1) We will assume that the *mixture* is the same throughout the whole of the system.

(2) We will not treat the different galactic latitudes separately.

The consequence will be that the resulting variations of density to which our discussion leads will not represent the actual variations which we would find if we travelled in space in any determined fixed direction, but a variation which will represent some average of what we would find on all our travels if we successively directed them to different regions of the sky.

Our present problem will thus be confined to finding out :—

(*a*) The mixture law.

(*b*) The mean star-density at different distances from the solar system.

If time allows, I will, at the end of this lecture, say a few words on the restrictions introduced, and the way to get rid of them.

As it is not given to us to make such travels through space as here imagined, we have to rely on more human methods for the solution of our problem.

*Determination of Distance.*

It is at once evident that there would be no difficulty at all if it were as easy to determine the distance of the stars as it is to determine the direction in which they stand. For in that case the stars would be localised in space, and it would be possible to construct a true model from which the peculiarities of the system might be studied.

It is a fact, however, that, with the exception of a hundred stars at most, we know nothing of the distances of the individual stars.

What is the cause of this state of things? It is owing to the fact that we have *two* eyes that we are enabled not only to perceive the direction in which external objects are situated, but to get an idea of their distance, to localise them in space. But this power is rather limited. For distances exceeding some hundreds of yards it utterly fails. The reason is that the distance between the eyes as compared with the distance to be evaluated becomes too small. Instruments have been devised by which the distance between the eyes is, as it were, artificially increased. With a good instrument of this sort distances of several miles may be evaluated. For still greater distances we may imagine each eye replaced by a photographic plate. This would even already be quite sufficient for one of the heavenly bodies, viz. for the moon.

At one and the same moment let a photograph of the moon and the surrounding stars be taken both at the Cape Observatory and at the Royal Observatory at Greenwich. Placing the two photographs side by side in the stereoscope, we shall clearly see the moon "hanging in space," and may evaluate its distance.

But already for the sun and the nearest planets, our next neighbours in the universe after the moon, the difficulty re-commences.

The reason is that any available distance on the earth, taken as eye-distance, is rather small for the purpose. However, owing to incredible perseverance and skill of several observers, and by substituting the most refined measurement for stereoscopic examination, astronomers have succeeded in overcoming the difficulty for the sun. I think we may say that at present we know its distance to within a thousandth part of its amount. Knowing the sun's distance, we get that of all the planets by a well-known relation existing between the planetary distances.

But now for the fixed stars, which must be hundreds of thousands of times further removed than the sun. There evidently can be no question of any sufficient eye-distance on our earth. Meanwhile, our success with the sun has provided us with a new eye-distance, 24,000 times greater than any possible eye-distance on the earth. For now that we know the distance at which the earth travels in its orbit round the sun, we can take the diameter of its orbit as our eye-distance. Photographs taken at epochs six months apart will represent the stellar world as seen from points the distance between which is already best expressed in the time it would take light to traverse it. The time would be about sixteen minutes.

However, even this distance, immense as it is, is on the whole inadequate for obtaining a stereoscopic view of the stars. It is only in quite exceptional cases that photographs on a large scale—that is, obtained by the aid of big telescopes—show any stereoscopic effect for fixed stars. By accurate measurement of the photos we may perhaps get somewhat beyond what we can attain by simple stereoscopic inspection, but, as we said a moment ago, astronomers have not succeeded in this way in determining the distance of more than a hundred stars in all.

How far we are still from getting good stereoscopic views appears clearly from the stereoscopic maps which your countryman, Mr. Heath, constructed, making use of the data obtained in the way presently to be considered. In order to get really good pictures, he found it necessary to increase the eye-distance furnished by the earth's orbit 10,000 times. Are there, then, no means of still increasing this eye-distance?

*Motion of Solar System through Space.*

There is one way, but it is a rather imperfect one. Sir William Herschel was the first to show, though certainly his data were still hardly sufficient for the purpose, that the whole of the solar system is moving through space in the direction towards the constellation of Hercules. Later observations and computations have confirmed Herschel's conclusions, and we have even been able of late to fix with some precision the velocity of this motion, which amounts to 20 kilometres per second. This velocity is a 15,000th part of the velocity of light. In the 150 years elapsed since Bradley determined for the first time the position of numerous stars with modern precision, the solar system must thus have covered a distance of exactly a hundredth part of a light-year, *i.e.* we are thus enabled to make pictures of the sky as seen from points of view at a mutual distance of a hundredth of a light-year. Our eye-distance of sixteen light minutes is thus increased more than 300-fold. True, this distance falls still considerably short of that adopted by Heath, but it appears that, for a considerable part of the stars, it is, though not nearly so great as might be desired, still in a certain way sufficient.

There is, however, a difficulty in the way, which prevents our pictures from giving a stereoscopic view of the stars at all, and thus prevents the determination of the distance of any star in this manner. The difficulty is that the changed directions in which, after the lapse of 150 years, we see the stars is not exclusively the consequence of the sun's motion through space, but is due also to a real motion of the stars themselves. The two causes of displacement which, in the case that we take the diameter of the earth's orbit as eye-distance, are separable by means of a simple device, become inseparable in the present case. In order to see whether this difficulty be or be not absolutely insuperable, I will take a parallel case *on the earth*.

At a certain distance we observe a cloud of insects hovering over a small pond. In order to evaluate the distance separating the insects from our eye, suppose that we make a photograph; then, after a few seconds, a second one from a slightly different standpoint. It must be evident that even if we have used an instrument which clearly shows the individual insects, the two pictures put in the stereoscope will not furnish a stereoscopic view of them individually; on the contrary, the picture as seen in the stereoscope will be perfectly chaotic. The reason, of course, is that in the interval between the taking of the two photographs the insects have moved. Does it follow that no evaluation of the distance can be obtained?

The answer must be, of any individual insect, *no*; but of the cloud, as a whole, we can evaluate its distance provided that the cloud, as a whole, has not moved; or, expressed more mathematically, provided that the centre of gravity of the cloud has not moved, we can derive the *average* distance [1] of all the insects. We shall be sure of

[1] The expression *average distance* ought, strictly speaking, to be replaced by the distance corresponding to the *average parallax*. For clearness sake I have ventured here and in what follows to substitute one expression for th other.

the immobility of the centre of gravity if we know that the direction of the motions of the insects is quite at random; but this is by no means required. The motion may be preferentially in a horizontal plane or along a determined line, say along the longer axis of the pond, provided only that the motions in any two opposite directions are equally frequent.

Not only that, even if the cloud, as a whole, is not immovable, we are not necessarily helpless. For, if the insect cloud and the photographer were both on a sailing vessel, circumstances would be the same as on the mainland, though now the cloud is in motion. Only, instead of the absolute displacement of the photographic apparatus, we must know the displacement relative to the ship, or rather *relative* to the *insect-cloud*. This, then, finally is the real thing wanted. We may obtain the distance of the insect-cloud, or, what comes to the same, the average distance of its members, as soon as we are able to find out the displacement of our point of view with regard to the centre of gravity of the cloud.

Our case is much the same in the world of the stars.

We shall be able to determine the average distance of the members of any arbitrary group of stars provided that we can find the motion of the solar system, both in amount and in direction, relative to the centre of gravity of the group.

Now, astronomical observations such as those which led the elder Herschel to his discovery of the solar motion through space enable us to determine the *direction* of the sun's motion relative to such groups as the stars of the third, fourth, &c., magnitude. Spectroscopy enables us to determine the *amount* of that motion.

We must be able, therefore, to find out the average distance of the stars in these groups. For other groups, such as the stars having an apparent centennial motion of 10″, 20″, &c., there is a difficulty. Still, however, we have succeeded in overcoming this difficulty by a somewhat indirect process, and pressing into service the stars of which the individual distances are known. This, then, is the upshot of astronomical work on the distances.

*What we know about Star-distance.*

*By direct measurement we know the distance of some hundred individual stars.*

*For the rest we know the average distance of any fairly numerous group of stars of determinate apparent magnitude and apparent motion.*[1]

The question is, Can this imperfect knowledge of the distances be considered as in any wise sufficient for obtaining an insight into the real arrangement of the stars in space? I think it can, and I will now try to show in what manner.

(*To be continued.*)

[1] At the present moment some objection might certainly still be made against the generality of this statement In fact, the scarcity of spectroscopic data is the cause that, though the determination of the solar motion separately for such groups as the stars of determinate magnitude and proper motion is quite possible, it has not yet been carried through. As a consequence, the results used in what follows still rest on the assumption that the centres of gravity of all the groups considered are at rest relative to each other. That this assumption must be probably true follows from the near identity of the *direction* of the sun's motions, furnished by the several groups.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

OXFORD.—The following is the text of the speeches delivered by Prof. Love in presenting recipients of the degree of D.Sc. *honoris causa* at the Encænia on June 24:—

FULGENCE RAYMOND.

Antequam de huius viri laudibus loquar, breviter dixerim centum fere abhinc annos celeberrimam medicorum scholam Parisiis exstitisse, eandem sæculo proximo exeunte, Charcotio familiam ducente, maxima laude floruisse. Charcotio successit Fulgentius Raymond, magistro discipulus clarissimus: quo rem feliciter navante valetudinarium Salpetriense, in quo quasi in aliquo orbis terræ theatro partes primarias agit, omnium in se ora convertit. Hic excultæ sunt plurimæ rationes, quæ ex eo pendent quod hi præ se ferunt qui affirmant posse corpori ægrotantis ipsam mentem mederi: quo in genere hic noster, dum de cerebri et de medullæ spinalis natura docte luculenterque disserit, laudem maximam consecutus est. Felicissimum profecto amicitiæ inter Britanniam et Galliam reconciliatæ documentum duco, quod hic vir de medicorum apud Gallos insignissimorum usu et rationibus magno medicorum nostrorum conventu Londinii nuper contionatus est.

JETHRO JUSTINIAN HARRIS TEALL.

Descriptioni Geologicæ, impensis publicis faciendæ, quæ saxorum solo Britannico subiectorum naturam, qua vi conflata sint, quo tempore coorta exquirit, præfectus est Jethro Justinianus Harris Teall. Qui vir, quo melius rem tantam conficeret, non in uno tantum genere laudis excellit: neque enim solum rationes quæ latissime patent animo comprehendere, sed etiam minutissima quæque et observare et repræsentare miro modo potest. His artibus usus, cum saxorum diversissimorum compages scrutaretur, omnia e montibus vi ignea liquefactis exorta esse cognovit: idem mutationes quas hæc saxa patiuntur gravi pondere oppressa subtilissime enarravit. Quo ingenio, qua peritia in hoc genere usus sit declarat ille liber de Insularum Britannicarum Petrologia conscriptus, quem aureolum esse ego iure dixerim.

JAMES WARD.

Inter Psychologos nemo clarior est quam Jacobus Ward, qui Psychologiam, cuius scientiæ proprium sit singulorum sensus tractare, non ex alia scientia pendere sed sui iuris esse constanter asseverat: cuius in ore semper est vox illa "Ego sum. Nihil mihi hoc verius?" Qui vir ita priorum repertis usus est ut erroribus vitatis longius progrederetur: idem si quid boni usquam invenisset non aspernatus novam, quæ latissime pateret, rationem excogitavit et necessitudinem quandam inter mentem nostram et rerum naturam intercedere docuit. Psychologiam etiam cum aliis scientiæ generibus artissime cohærere monstravit et omnibus qui cognoscendi ratio quæ sit investigant vel hominum moribus student utilissimam esse contendit. Neque ei satis erat huic scientiæ novum quasi fundamentum præbere, sed multorum diverso in genere philosophorum opiniones reprehendit: quæ omnia in libro paucos abhinc annos edito pervulgata cum iis qui rerum naturæ investigandæ operam dant tum iis qui philosophiæ potissimum incumbunt maxime profuerunt.

MANCHESTER.—Lord Morley, Chancellor of the University, has nominated the following as recipients of honorary degrees on the occasion of his installation, which has been fixed for July 9:—the Right Hon. A. J. Balfour, Mr. E. J. Broadfield (treasurer of the University), Mr. Andrew Carnegie, Lord Courtney of Penwith, Lord Curzon of Kedleston, Sir Ed. Donner, Bart., Dr. A. M. Fairburn (principal of Mansfield College, Oxford), Sir Frank Forbes Adam (chairman of the university council), the Right Hon. R. B. Haldane, Sir H. F. Hibbert (chairman of the Lancashire Education Committee), Sir W. H. Houldsworth, Bart., Prof. Henry Jackson, Sir William Mather, Mr. J. Cosmo Melvill (donor to the Manchester Museum of the Cosmo-Melvill herbarium), and Sir Edward Maunde Thompson. In addition, the following honorary degrees will be conferred:—*LL.D.*, Mr. A. J. Evans (keeper of the Ashmolean Museum) and Mr. William Farrer (editor of the "Victoria County History of Lancashire"; *D.Sc.*, Emeritus Prof. Gamgee.

Mr. R. E. Slade has been elected to a Gartside travelling scholarship. Dr. Hans Geiger has been re-appointed to the Harling fellowship in physics.

THE Countess of Bective will present the prizes at the Horticultural College, Swanley, Kent, on Tuesday, July 14. Sir John Cockburn, K.C.M.G., will take the chair at 4 p.m.

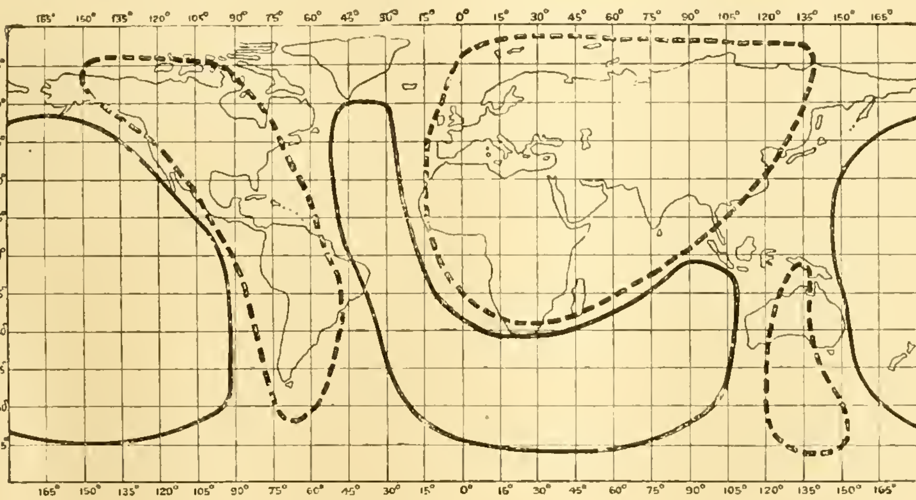
WE are glad to be able to announce that a petition for a charter for a University of Bristol has been sent to the Privy Council. A concordat is being arrived at between University College, Bristol, and the Merchant Venturers' Society, which has for many years been identified with work of technical and secondary education in the city. The most liberal support for the University scheme has come from various members of the Wills family, no less a sum than 135,000*l.* having been promised toward its realisation by them. Of this amount, Mr. H. O. Wills has promised 100,000*l.*, Lord Winterstoke (formerly Sir W. H. Wills) 20,000*l.*, and Sir Frederick Wills 10,000*l.* More money is, however, still required to establish the University in a satisfactory manner; and it is to be hoped that other merchant princes of Bristol will follow the magnificent example which the Wills family has given them.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, April 30.—"Note on the Representation of the Earth's Surface by Means of Spherical Harmonics of the First Three Degrees." By Prof. A. E. H. **Love**, F.R.S.

In a previous paper the author had concluded from dynamical considerations that those elevations and depressions on the surface of the globe which correspond with continents and oceans should be capable of being represented, in respect of their main features, by means of spherical harmonics of the first, second, and third degrees. A rough spherical harmonic analysis of the




actual elevations and depressions yielded a rather imperfect representation of the surface, which nevertheless offered a general resemblance to the actual distribution of land and water. It had, however, certain definite defects. To alter the computed figure it is necessary to change appropriately the coefficients of the spherical harmonic expression by which it is proposed to represent the elevation of the surface above the mean level. In the present paper there is recorded the best of many sets of trial coefficients, and the result is shown on the accompanying chart. In this chart the fine continuous line is a rough outline of the actual land of the globe, drawn in such a way that all degrees of latitude or of longitude have the same value on the map; the heavy line is the zero line of the surface harmonic with the chosen coefficients; the dotted line is the contour line along which the computed elevation is equal to one-tenth of its maximum value.

"The Relation between the Crystalline Form and the Chemical Constitution of the Picryl Derivatives." By G. **Jerusalem** and Prof. W. J. **Pope**, F.R.S.

By a method which depends upon dividing up the space occupied by a crystalline substance into polyhedral cells, each of which is assumed to be the habitat of but one atom, Barlow and Pope have been able to determine the general relation which exists between crystalline form and chemical constitution. They conclude that the polyhedral cells, each of which represents the domain of one atom and which fit together without interstices to form the crystal structure, possess volumes which are approximately proportional in magnitude to the lowest valencies exhibited by the elements which they respectively contain. The assemblages obtained by packing together the atomic domains mentioned are partitionable into identical units, each of which represents in composition, constitution, and configuration a chemical molecule of the substance concerned. The relation between the crystalline form and chemical constitution of a series of substances is conveniently illustrated by comparing the dimensions of polyhedra, of which the volumes are represented by the sum, W, of the valencies of the atoms composing the molecules, and of which the relative dimensions are the crystallographic axial ratios $a:b:c$. The dimensions referred to are termed the equivalence parameters $x:y:z$, and are calculated from the relations that $a:b:c=x:y:z$ and $xyz=W$.

In the present paper the above considerations are applied to a number of derivatives of picric acid and allied substances; it is shown that in this series one of the three equivalence parameters remains approximately constant, and has about the value of $z$ in the equivalence parameters of crystalline benzene, namely, $x:y:z=3{\cdot}101:3{\cdot}480:2{\cdot}780$. The direction in which the dimension $z$ is measured in benzene is that in which columns formed by superposing triangularly arranged groups of three polyhedra, each occupied by a carbon atom, occur throughout the assemblage representing crystallised benzene. It is concluded that the crystal structures of the picryl derivatives are derived from that of benzene by moving the columns of carbon domains apart and packing the substituting groups in between them in accordance with the method already described by Barlow and Pope.

"On the Hysteresis Loss and other Properties of Iron Alloys under very Small Magnetic Forces." By Prof. Ernest **Wilson**, V. H. **Winson**, and G. F. **O'Dell**. Communicated by Sir William H. Preece, K.C.B., F.R.S.

The experiments were carried out on two alloys of iron, namely, "stalloy," of which the distinguishing feature is that it contains about 3 per cent. of silicon, and "lohys," which is a good sample of transformer plate. The principal object of the research is to find the magnetic properties of these materials under small magnetising forces, especially as regards hysteresis loss. Information is also given on the specific resistance and temperature coefficients of the materials.

For the magnetic tests the specimens are in the form of rings composed of stampings, and the ballistic galvanometer method has been employed.

Lord Rayleigh found by the magnetometer method that in the case of Swedish iron the permeability was nearly constant when the magnetic force (H) varied from 0·00004 to 0·04. In the present experiments the permeability also tends to become constant, the limiting values being 260 for stalloy and 222 for lohys. As regards the maximum value of the permeability, the results obtained have been compared with published figures for a very pure iron and a good sample of plate rolled from Swedish iron. For these materials the maximum permeabilities are respectively 5480 and 4450, and occur for values of the magnetic induction (B) of 9100 and 7000 respectively. For stalloy and lohys the maximum permeabilities are 4520 and 3280, and occur for values of B of 5000 and 5500 respectively.

As regards hysteresis loss, the following figures are given in full, as they form the most important part of the paper. The loss for stalloy is somewhat lower than that for the pure iron specimen above alluded to, while that for lohys is slightly higher.

| Stalloy | | | Lohys | | |
|---|---|---|---|---|---|
| $B_{max.}$ | $H_{max}$ | Ergs per cycle per cubic centimetre | $B_{max.}$ | $H_{max.}$ | Ergs per cycle per cubic centimetre |
| 0·1267 | 0·000474 | — | 0·70 | 0·00311 | — |
| 0·1918 | 0·000739 | — | 1·95 | 0·0087 | — |
| 0·674 | 0·00267 | — | 4·25 | 0·0181 | 0·000725 |
| 0·937 | 0·00357 | 0·0000111 | 8·99 | 0·0352 | 0·00645 |
| 1·870 | 0·00695 | 0·0000072 | 15·0 | 0·0528 | 0·0224 |
| 3·60 | 0·01286 | 0·000347 | 37·4 | 0·1042 | 0·152 |
| 8·25 | 0·0251 | 0·00384 | 84·1 | 0·1860 | 0·84 |
| *13·02 | 0·0358 | 0·01153 | 286 | 0·404 | 8·80 |
| 38·0 | 0·080 | 0·0811 | 568 | 0·565 | 32·2 |
| 94·1 | 0·157 | 0·5680 | 965 | 0·697 | 85·0 |
| 171·0 | 0·245 | 1·686 | 1930 | 0·905 | 253 |
| *269 | 0·312 | 4·810 | 3780 | 1·260 | 725 |
| *629 | 0·420 | 21·65 | 6280 | 1·960 | 1620 |
| 2245 | 0·677 | 203·0 | 7970 | 2·740 | 2375 |
| *6050 | 1·354 | 1030·0 | 11510 | 6·575 | 5060 |
| 8200 | 2·130 | 1688 | 13440 | 14·90 | 7050 |
| 9810 | 3·26 | 2335 | | | |
| 11500 | 5·71 | 3110 | | | |
| 13480 | 16·20 | 4530 | | | |

The stalloy specimen requires careful attention in order that a truly symmetrical hysteresis loop may be obtained, more especially for values of B between 200 and 8000. In an extreme case, after reducing the force H from about 63 to 0·712 without subjecting the specimen to a series of reversals of the magnetic force as it was reduced, a complete hysteresis loop was obtained. This loop is unsymmetrical in the sense that if the axis of H be so placed that the coercive forces are equal, the positive and negative values of the maximum induction B are not equal, but the positive and negative values of the residual magnetism are equal. The value of the permeability defined as the ratio of half the total change of magnetic induction to the maximum value of H is less than is the case when the loop is truly symmetrical. In the table the figures for loops which are not quite symmetrical are indicated by an asterisk.

The Steinmetz coefficients have also been investigated, the relation being ergs per cycle per cubic centimetre $= \alpha B^{\beta}$. Both coefficients vary considerably. For stalloy the coefficients are very nearly constant between values of B of 600 and 11,000; over this range $\beta = 1{\cdot}71$ and $\alpha = 0{\cdot}000342$. For values of B from 0·937 to 8·25 the coefficient $\beta$ is as high as 2·69. In the case of lohys, between values of 500 and 8000 for B, the values $\beta = 1{\cdot}62$ and $\alpha = 0{\cdot}00122$ approximately hold. In this case also the coefficient $\beta$ rises to a high value when B is small.

Another matter investigated is the value of $\int H dB / H_0 B_{max}$, where $H_0$ is the coercive force. Dr. Sumpner has pointed out that this quantity is a linear function of $B_{max}$ over a large range. For stalloy and lohys the relation only holds apparently between values of B of 1000 and 9000.

The specific resistance and temperature coefficients were obtained in the case of each of the materials. The following figures are in each case the mean of the results of three independent experiments:—

| | Mean specific resistance at 15° C. in $10^{-6}$ ohms per c.cm. | Mean temperature coefficients 0° to 50° C. | Mean temperature coefficients 0° to 100° C. |
|---|---|---|---|
| Stalloy ... ... | 49·63 ... | 0·000975 ... | 0·00103 |
| Lohys ... ... | 14·25 ... | 0·00424 ... | 0·00446 |

It will be seen that stalloy has a high specific resistance, which is important in connection with eddy current loss, as this is thereby reduced.

May 28.—"Effect of a Cross Wind on Rifled Projectiles." By A. **Mallock**, F.R.S.

The effect of wind on rifled projectiles is important for practical reasons, especially in the case of small arms, but the object of the present note is not so much to determine the actual effect of wind as to show that accurate experiments on the subject would afford valuable information concerning the flight of projectiles in still air.

It is easily shown that if the air resistance acts always in the direction of the resultant of the velocities of the wind and the projectile, the angle made by the resultant velocity with the line of aim remains constant throughout the range.

In order, however, that the resistance may act in the direction of the resultant velocity, the projectile must be symmetrical about that direction. This, in the case of any form except a sphere, means that the principal axis of the projectile must take the direction of the resultant velocity.

If this is assumed and we take $v_0$ as the initial velocity of the shot, $w$ as the velocity of the wind ($w/v_0$ being small), and $\eta$ as the coordinate of the shot perpendicular to the line of aim, we have at the time $t$

$$\eta = \frac{w}{v_0}(v_0 t - R) \text{ or } w\left(t - \frac{R}{v_0}\right) \qquad (1)$$

This result was first given by Captain Younghusband, R.N., and would be correct if the axis of the projectile set itself in the direction of the resultant velocity from the very beginning.

At first, however, the axis makes an angle $w/v_0$ with the velocity resultant, and the resistance has therefore a horizontal component at right angles to that resultant, for the same reason that a small angle between the axis of the projectile and the tangent to the trajectory produces an upward force on the former.

The question, then, as to how far (1) may be looked on as giving a true value for the effect of the wind turns on the rate at which the projectile can set its axis in the direction of the velocity resultant.

It is shown, however, in a former paper,[1] that to produce a given angular velocity of the axis of a projectile the couple must vary as the fourth power of the linear dimension.

For a given inclination of the axis to the direction of motion the couple applied by action of the air will vary as the cube of the linear dimension; thus the angular velocity of the axis will be inversely as the linear dimension, or, in other words, the time for a given angle will be as the linear dimensions.

For a given inclination the lateral force will be as the square of the linear dimension, and the distance to which the lateral force will carry the projectile while turning through the angle $w/v_0$ will be proportional to the linear dimension.

Thus instead of the expression in (1) we should write

$$\eta = AL + w(t - R/v_0), \qquad (2)$$

where L denotes the linear dimension and A some constant depending on the form, weight, and initial velocity of the projectile.

If careful experiments were made on wind deflection, the velocity of the wind being recorded at several positions along the range at the instant that each shot was fired, the value of A might be determined, and therefrom the angle which the axis of a projectile fired in still air makes with the tangent to the trajectory.

**Physical Society**, June 12.—Dr. Charles Chree, F.R.S., president, in the chair.—Experiments on a directive system of wireless telegraphy: E. **Bellini** and A. **Tosi**. The authors describe the results obtained in the course of their work upon a further development of their original directive system. In the earlier method previously described (*Electrical Engineering*, ii., p. 771, 1907, and iii., p. 348, 1908) it was not possible to say from which side of the receiving station the transmitted waves arrived, for though the radiation was practically confined to the plane of the aërial system, it was emitted equally in the opposite direction to that desired. In the new unilateral system the waves are sent in a single direction only, and the problem of getting rid of the backwardly extending radiation has thus been solved. The method adopted consists in superposing a bilateral directive system, as previously described, upon an ordinary or vertical antenna system. The system of unilateral directive wireless tele-

[1] "The Behaviour of Rifled Projectiles in Air," Roy. Soc. Proc., vol. lxxix., p. 547.

graphy described in the present paper is of special interest owing to the facility with which it is possible to change over from one system to the other, thus, from the ordinary vertical antenna system to the bilateral directive or the unilateral directive, or *vice versâ*. The aërial arrangements, moreover, remain exceedingly simple. When a message from a station of unknown position is expected, the vertical antenna or ordinary system would be employed; on once effecting reception, one can pass to the bilateral or unilateral directive system, and thus determine the direction and on which side the transmitting station lies, at the same time making oneself independent of other transmissions. In the same way, with the transmission, the vertical antenna would be employed for calling up an unknown station or for simultaneously sending to several stations; on getting a reply the operator can readily determine the position of the receiving station, with the aid of the unilateral system, and thenceforth will transmit solely in that direction.—The lateral vibration and deflection of clamped-directed bars: Dr. J. **Morrow.** This is an investigation of the problems which arise in connection with the lateral vibrations of clamped-directed bars. The term "directed" is used to describe the extremity of a bar which is constrained to maintain its original direction, but is free to take up any position of lateral deflection. These terminal conditions are mentioned in Rayleigh's "Sound," but are dismissed on the ground that the directed end cannot be realised experimentally. In the present paper, however, it is shown that the "directed" end is of great importance and of frequent occurrence in engineering practice, and, further, that by the aid of a simple device it can easily be investigated in the laboratory.—The resistance of a conductor of uniform thickness whose breadth suddenly changes, and on the shape of the stream-lines: Prof. C. H. **Lees.** A knowledge of the resistance of a conductor the section of which suddenly changes is of considerable practical importance, but mathematical difficulties have prevented an exact solution of the problem. The paper shows that the resistance between two transverse sections through points situated at considerable distance from the change of section on opposite sides of it is equal to the sum of the resistances of the portions of conductor between each of the two sections and the change of section, each considered as part of an infinite length, plus the resistance of a length of either conductor equal to its breadth multiplied by an expression given.—The inductance of two parallel wires: Dr. J. W. **Nicholson.** When direct and return currents flow in two wires of great length, and the alternation is not rapid, the effective self-induction per unit length of the system may be calculated readily by simple integration. If the wires have radii $a$, $b$, and permeabilities $\mu$, $\nu$, and if C be the distance between their axes,

$$L = 2 \log c^2/ab + \tfrac{1}{2}(\mu + \nu).$$

This formula is often of little practical use when the frequency of alternation is several thousands per second. Such frequencies are of constant use in practical work. For example, in the measurement of small inductances by Mr. Campbell's method, it is necessary to employ long leads in order to keep them at some considerable distance from the bridge and other circuits. The self-induction of these leads must be small, and a calculation of its value is very desirable. The general case presents very great mathematical difficulty, but the solutions given in the paper appear to include most cases of practical utility.—Homogeneous secondary radiation: Dr. **Barkla** and Mr. **Sadler.**—(1) Note on the amount of water in a cloud formed by expansion of moist air; (2) an elementary treatment of the motion of a charged particle in a combined electric and magnetic field: Prof. **Morton.**

DUBLIN.

**Royal Irish Academy,** May 11.—Dr. F. A. Tarleton, president, in the chair.—A synopsis of Irish algæ, freshwater and marine: J. **Adams.** After an historical account of past investigations on Irish algæ, and the various attempts to divide the country into botanical districts, there follow complete lists of the genera and species, and their geographical distribution in each of the four provinces is briefly indicated. For facility of reference the genera and species belonging to each of the main groups of algæ are arranged in alphabetical order. In all, 2224 species are included, 1379 species being fresh-water and 845 species marine. A summary of the total species recorded for each province is given, followed by a brief description of the local distribution of the rarer or more interesting species. At the end is a bibliography in which all known sources of information on the distribution of Irish algæ are indicated.

May 25.—Dr. F. A. Tarleton, president, in the chair.—Some unpublished work of the late Prof. Charles J. Joly, F.R.S., on geometry, part i.: Rev. W. R. Westropp **Roberts.** The author discusses curves, both plain and twisted, by expressing the coordinates of such curves in terms of a parameter, and deduces from this point of view the nature of their singularities.—Some general principles of the theory of dimensions: E. E. **Fournier d'Albe.** The author discusses the methods of discovering relations between physical quantities by means of their dimensions. He shows that when the quantity investigated is purely mechanical, and expressible in terms of length, mass, and time, it can depend upon not more than three independent variables, which are also purely mechanical quantities. When the number of fundamental units is increased, as by adding angle, temperature, or electric quantity, the number of independent physical variables is increased in proportion. The attempts to account mechanically for forces acting at a distance by means of dimensional formulæ are criticised.

PARIS.

**Academy of Sciences,** June 22.—M. H. Becquerel in the chair.—Study of the phenomena shown by concave wings in the stationary, floating, and hovering flight of birds: Marcel **Deprez.** A calculation of the horizontal and vertical components of the forces resulting from the action of air in motion on the surfaces of wings, supposed curved. The formula arrived at contains no other experimental condition than the mass of unit volume of air, thus dispensing with the empirical coefficients commonly employed.—M. Gaillot was elected a correspondant in the section of astronomy, in the place of the late M. Trepied.—The analysis of polymorphic curves: Émile **Borel.**—The orientation of an anisotropic ellipsoid in a uniform field: Georges **Meslin.**—The nature of charges of positive electricity and the existence of positive electrons: Jean **Becquerel.** The recent work by the author on the magneto-optic phenomena of the rare earths over a wide scale of temperature leads to the view that positive electrons exist; Lilienfeld has also obtained phenomena which he attributes to positive electrons, but these results have been negatived by Bestelmeyer and Marsh. In the present paper an account is given of experiments with a modified form of Crookes's tube. The results confirm the hypothesis of the existence of positive electrons.—The photographic registration of sound vibrations: Georges and Gustave **Laudet.** These photographs, which were obtained by purely mechanical means and without the aid of a microphone, are distinguished by the clearness of the line produced. Reproductions of the vowels and the sibilants *s* and *z* and of the word Laudet are given. No details are given of the method employed.—The relation between the biochemical effects of radiations and the quantity absorbed: H. **Guilleminot.** In studying the biochemical effects of the X-rays, it is more important to make quantitative measurements on the energy absorbed in the material than to measure the energy of the incident bundle. Fluoroscopic measurements of the incident rays show great divergences between the biochemical effects of the X-rays and the radium rays; these discrepancies disappear when the amount of energy really absorbed in the two cases is studied.—The heat of neutralisation of acetic and benzoic acids by aniline in benzene solution: Léo **Vignon** and M. **Évieux.** Aniline does not react to form salts with acetic and benzoic acids in benzene solutions. Aniline benzoate and acetate are destroyed by solution in benzene.—A new method of separation of silica and tungstic anhydride: Ed. **Defacqz.** At a red heat silica is not reduced by hydrogen, whereas tungstic anhydride is readily reduced to lower oxides under the same conditions. The latter are readily removed by heating in a current of chlorine, forming volatile chlorides and oxychlorides, the silica remaining unchanged in the boat.—A new automatic principle applied to the carburettor: A. **Lauret.** A description of a new form of carburettor for internal combustion engines possessing the advantages of being free from moving parts, strictly automatic in its action, and freedom from liability to derangement.—The constitution of some derivatives of diphenylmethane and the preparation of some orthodiamines of this series: H. **Duval.**—The αα-dialkyl-β-ketonic alcohols and their transposition by dehydration: E. E. **Blaise** and I. **Herman.** The course of the transposition under the influence of alkalis of the ketone

$$CH_2(OH)—C(CH_3)_2—CO—C_2H_5$$

is shown to consist probably in a dehydration to

$$—CH—C(CH_3)_2—CO—C_2H_5,$$

followed by a migration of a methyl group resulting in the ketone

$$CH_3—CH=C(CH_3)—CO—C_2H_5.$$

—Study of the molecular concentration of the liquids of the organism in the pathological state: Adolphe **Javal.** The cryoscopic constant of liquids extracted from pathological growths is generally greater than the normal figure $-0^{\circ}\cdot56$, and it is shown that this cannot be accounted for by the presence of an abnormal excess of sodium chloride. The amount of nitrogenous products in these pathological fluids is above the normal, but is insufficient to account for the observed hypertonicity.—A chemical character differentiating the orthoses and the microclines: Ph. **Barbier.** The orthoses uniformly contain small quantities either of lithium or rubidium, frequently both; these elements are absent from the microclines. The exact method of separating these alkalis is given in detail.—*Synalpheion giardi*, an entoniscian parasite of *Synalpheus longicarpus*: H. **Coutière.**—The comparative anatomy and histology of the Blochmann glands in the Tectibranchs: Rémy **Perrier** and Henri **Fischer.**—Chromatic reactions and classification of the leucocytic granulations of the invertebrates: M. **Kolmann.**—Vascular elasticity and its variations: Gabriel **Arthaud.**—The acetyl derivative of atoxyl in sleeping sickness: Paul **Salmon.** The acetyl derivative of atoxyl has been in the form of sodium salt (sodium acetyl-para-amido-phenylarseniate) in experiments on the treatment of sleeping sickness. It possesses the advantages of being perfectly soluble, sterilisable at 100° C. without decomposition, and less toxic than atoxyl itself. Experiments on rats, guinea-pigs, and apes infected with *Trypanosoma gambiense* demonstrate that acetyl-atoxyl may be administered in doses four times as great as atoxyl, causing the disappearance of the trypanosome from the blood of the animals.—The geological constitution of the *massif* of Beni Snassen, Morocco: Louis **Gentil.**—The eolian origin of the finely divided minerals found on the sea floor: M. **Thoulet.** An account of a quantitative study of atmospheric dust collected on the tower of Nancy Cathedral, 75 metres above the ground.—Two new sheets of the industrial map of zoology of the coasts of France: M. **Joubin.**—The torrential origin of ruin-shaped limestone rocks: E. A. **Martel.**—The radio-activity of the waters of Ax (Ariège), demonstrated by photography: F. **Garrigou.**—Rain and the state of water-courses: Paul **Garrigou-Lagrange.**—The ablation of the glacier at Chamonix during fifteen years and during fifty years: J. **Vallot.**—New magnetic determinations in the western basin of the Mediterranean: Charles **Nordmann.**

NEW SOUTH WALES.

**Linnean Society,** March 25.—Mr. A. H. Lucas, president, in the chair.—Notes on the native flora of New South Wales, part vi., Deepwater to Torrington and Emmaville: R. H. **Cambage.** Although the locality the flora of which is described lies to the west of the Great Dividing Range, a large percentage of the plants noticed occur also in the Sydney district. The similarity of the two floras is attributable to somewhat similar geological formations, for while the Sydney rocks are sandstone, the acid granites of Torrington contain quite 75 per cent. of silica, and the soil derived therefrom approximates to that of a sandstone area. Reference is made to the occurrence of both inland and coastal plants, an association which is intelligible on the ground that the effect of higher altitude is counterbalanced by that of a more northerly latitude.—Note on the breeding habits of the red-bellied newt (*Molge pyrrhogastra*, Boie): E. R. **Waite.**

CAPE TOWN.

**Royal Society of South Africa,** April 6.—Mr. S. S. Hough, F.R.S., president, in the chair.—Transvaal sea-level temperatures: R. T. A. **Innes.** The object of the paper was to find what reductions applied to temperature readings in the Transvaal would reduce them to sea-level temperatures. For this purpose, a curve was plotted with the temperature entered horizontally and the altitudes vertically. This was assumed to be a parabola, and the correction was calculated on this assumption. A comparison with Buchan's maps in Bartholomew's Meteorological Atlas showed great differences. These the writer attributed to the fact that Buchan had no South African data on which to base his correction.—The geology and mineralogy of Albany: Prof. **Young.** The author described the evidence he had of volcanic action having occurred in the Albany district along a line of crustal weakness running east and west some miles to the south of Grahamstown. He described some investigations he had carried out on some of the rocks and minerals found in the neighbourhood of this volcanic line. The evidence goes to show that the district is mineralised with gold and other rare metals, and that a mineral grease or oil occurs in association with the rare metals. He also suggested several chemical reasons to account for the failure of most South African assayers to detect these metals, while the European assayers have found them in several hundreds of samples from Albany during the last two years.

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THURSDAY, JULY 9, 1908.

## AFRICAN NATURE NOTES.

*African Nature Notes and Reminiscences.* By F. C. Selous. With a foreword by President Roosevelt. Pp. xxx+356; illustrated. (London: Macmillan and Co., Ltd., 1908.) Price 10s. net.

MR. SELOUS has been well advised to commit to a book his recollections of natural history in connection with the big game of Africa. There is still a branch of zoological science which may be called by the nearly discarded title of "natural history" instead of biology; and although the latter is the more important type of research, biologists are probably the first to desire to couple with their knowledge of the body of the dead organism accurate information as to its life-habits; for this must evidently furnish the necessary explanation of peculiarity of structure while being frequently an additional aid to classification.

Mr. Selous has long been celebrated as one of the first among big-game hunters and collectors for a period of something like thirty years. He, and a few like him, have enormously increased our knowledge of the world's larger mammalian fauna. Unfortunately he has few compeers in proportion to the army of useless game-slaughterers who are devastating the world and destroying what remains of its notable birds and mammals.

The national collection in the British Museum is an eloquent testimony to the fact that many victims of Mr. Selous's unerring rifle have not died in vain, have not been killed uselessly. At the same time, his pursuit of big and small game in South and East Africa, Asia Minor, and in America has been accompanied by most careful note-taking as to the life-habits of the creatures he pursued—pursued very often not to kill, but to observe.

In the book under review, the two preliminary chapters call into question theories as to the protective coloration of mammals and birds, and the value of supposed recognition marks. President Roosevelt joins with Mr. Selous in somewhat decrying the cogency of theories in vogue. It would seem to the reviewer that both writers were a little querulous in their desire to differ from a number of established authorities on zoology (most of them field naturalists also).

The coloration and marking of living creatures—let us say for the moment beasts and birds—arises from such a complication of causes that it can only as yet be explained partially, and by a variety of reasons. One of these is that the greater magnificence of appearance in the male serves to attract the notice and compliance of the female. This has been contested by some writers, but it still remains a valid theory. The most important explanation, however, yet advanced for the colour or markings of the majority of animals is that their appearance is thereby adapted to their surroundings, and enables them either as pursuer or pursued to escape observation. It would seem to the reviewer that in the main few persons who have studied wild life can refuse to believe in the existence and practical value of protective or assimilative coloration.

Who, for example, that has seen a bittern amongst the reeds and tree stumps can refuse to believe that for some purpose best known to itself the creature is posing in such a way that its marking, colouring and attitude deceive the eye of everything that is not a bittern?

Even the magnificent crimson and blue-green bee-eaters of tropical Africa have a way of perching on bare bushes so that they exactly resemble large crimson flowers. The precise purpose in this deception is no doubt to attract insects on which they pounce. The reviewer has witnessed this deception repeatedly, thinking at a little distance that he was gazing at a magnificent example of an Erythrina shrub in full flower until the flowers flew away.

Mr. Selous repudiates the idea that giraffes can find any advantage in resembling tree trunks that have been blasted by lightning, as they do invariably when they are immobile and holding their necks very erect. The reviewer can aver that in Eastern Equatorial and South-west Africa he has been repeatedly deceived (although his sight is good enough to be compared with that of a negro) by this appearance of the giraffe sentries. They were old males or females, whose colouring at the distance seemed resolved into black and white, and they appeared remarkably to resemble the trunks of the acacia trees that have been blasted by lightning and stripped by storms.

Innumerable other cases of deception in coloration on the part of large and small game could be cited.

Mr. Selous asks what use it is, since the carnivora almost invariably hunt by scent and at night. He seems to forget that the most dangerous of all carnivores is man, predatory man, and that man has co-existed with most modern types of birds and beasts for hundreds of thousands of years, back to the end of the Tertiary period at any rate, quite long enough for giraffes, antelope, deer, and innumerable other beasts (and birds) to have developed a special aptitude and cunning for evading his observation. For man, since even before he was truly man, has invariably hunted by *sight*, and not by scent.

It is scarcely necessary to state that Mr. Selous's notes on the life-history of the lion, the spotted hyena, the Cape buffalo, and the rhinoceros are interesting, original, and obviously true. This is no second-hand information; a good deal of it, moreover, is quite novel. Mr. Selous discountenances the idea that the lion advances on his prey by tremendous leaps; rather (according to him) it comes rushing on all four legs as a dog might do, and uses its teeth for the death-stroke in preference to a blow or tearing with the paw and claws. The advantage of the curved claws and strength of limb would rather lie in their enabling the lion to hold on to his prey while the great canine teeth severed arteries and pierced brain cases or spinal columns. The lion, he thinks, developed its mane in the colder climate of Europe or western Asia before it followed the big game into Africa (the last refuge of the latter before the advancing power of Neolithic man). But if protection from cold and wet be the inducement which led to the development of a mane in the male lion, how about the lioness? The more probable explanation is that the mane of the lion arose both as a male ornament and as a protection for the throat and chest in sexual combats with other males. Mr. Selous comments on the distinctly spotted limbs possessed by some adult lions and lionesses; he quotes the special name given to this type by Boer hunters. He will have been interested in the paper by Mr. R. I. Pocock in the Annals and Magazine of Natural History (November, 1907) on the significance of the pattern—the rosettes, spots and stripes—of the cubs of lions (and of pumas).

The author's notes on the fluctuations of the abundance and distribution of the tsetse fly and its correlation with the abundance or scarcity of the buffalo are important contributions to a subject of great economic importance. His remarkable sporting adventures are the more thrilling because of their obvious truth, and the quiet style of narration.

The last chapter in the book is as valuable as any in a work which is interesting from beginning to end. It is devoted to the Bushmen of South Africa—more especially the Masarwa dwelling on the verge of the Bechuana countries.

Mr. Caldwell's drawings are admirable (especially the study of galloping gemsbuck). Very interesting are the photographs and description contributed by an American sportsman, Mr. Max Fleischmann, of a rhinoceros being dragged under water (presumably) by crocodiles.

H. H. Johnston.

## *WATER POWER.*

*Hydraulics and its Applications.* By A. H. Gibson. Pp. xvi+757; with diagrams and illustrations. (London: Archibald Constable and Co., Ltd., 1908.) Price 18*s*. net.

IN this intensely practical age, science is chiefly exploited for utilitarian ends. The fascination of experimental research lies, as Cap'n Cuttle would observe, "in the application thereof." We seek to know, not for any mere pleasure to be derived from the acquisition of knowledge, but in order to bring that knowledge to bear upon everyday problems of life, labour, and economy.

There is something, therefore, particularly fitting and appropriate in the title of Mr. Gibson's book, "Hydraulics and its Applications," for hydraulics is an eminently practical branch of natural science. Moreover, it is a science difficult to define in that it has no fixed limitations. It embraces the study of all questions in hydro-mechanics in which the motion of water produces or is connected in any way with useful work. In a very special sense it lies within the province of the engineer and the manufacturer.

On its theoretical side, hydraulics presents a number of difficulties. Assumptions have to be made which are not strictly justifiable in reality; yet without them the solution of problems would be well-nigh impracticable. There is, therefore, something necessarily of the nature of compromise about the subject, and Mr. Gibson strikes this keynote at the outset of his work by explaining that the questions of hydraulics can only be discussed on the basis of the assumption that water is a perfect fluid (which it is not), absolutely non-viscous and inelastic, with the introduction of empirical constants to bring theoretical results into conformity with the records of actual observation.

Despite, however, the very practical suggestion of its title, Mr. Gibson's treatise must be set down as primarily a theoretical work. It postulates a knowledge of mathematics and mathematical processes which the ordinary practical man unfortunately rarely possesses. And while the operator, as distinct from the experimentalist, will no doubt fully appreciate the useful data contained in the volume and the information condensed into working formulæ, he will at the same time be inclined to regret that Mr. Gibson has not dealt a little more completely with the practical side of the subject, by describing in greater detail the remarkable variety of ways in which hydraulic machinery is utilised in commerce, manufactures, and the arts.

Commencing with two prefatory chapters on hydrostatics and the physical properties of water, in which such matters as capillarity and the laws of floating bodies are briefly discussed, the author introduces his main subject in chapter iii. by describing the experimental results obtained by Profs. Osborne Reynolds and Hele-Shaw in regard to stream line flow. The motion of fluids is then mathematically investigated and its phenomena explained in relation to pipes, bends, vortices, and orifices. This leads on to the laws of fluid friction and the resistance of ships, whence the author reverts once more to pipe and channel flow, and the various sources of loss of head and velocity. Chapter x. takes up the question of impact of jets and of pressure on submerged planes. It is not until chapter xi. is reached that the practical side of the subject comes under discussion, and then the various and well-known types of water-wheel are duly described and illustrated, including the Pelton motor. Chapter xii. deals with turbine forms, and chapter xiii. with the theory of turbine design. In chapter xiv. there is an account of the hydraulic reciprocating engine, with examples of the Brotherhood and Rigg machines. Chapters xv. to xvii. are devoted to pumps, including the hydraulic ram. The transmission of energy by means of pressure mains forms the subject of chapter xviii., while the final chapter contains a brief review of a number of important appliances: lifts, hoists, jacks, cranes, and jiggers. It is this latter portion of the book—the manipulative aspect of hydraulics—that one would have liked to see expanded, even, if necessary, at the expense of some of the earlier mathematical matter. The commerce of Great Britain is essentially maritime, and a very large proportion of port and harbour machinery is hydraulic. Dock gates, sluice penstocks, capstans, coal elevators and tips are worked in the great majority of cases by hydraulic power, and despite their importance none of these appliances is illustrated in the book. Quay cranes also, a most important class, are not represented, though some of them are capable of dealing with loads up to 150 tons.

We think that in one or two cases the matter might have been arranged to rather better advantage, but, on the whole, we have no hesitation in saying that the book is an excellent contribution to the literature of the subject, and embodies the result of no little personal investigation and research. It is specially a student's book, and will appeal more particularly to those who are already equipped with some fundamental knowledge of hydraulics. The book is clearly printed and well illustrated.

## THE DISCOVERY OF THE WEIGHT OF THE AIR.

*Essais de Jean Rey*, 1630. Édition nouvelle avec commentaire par Maurice Petit. Pp. xxvii+191. (Paris: A. Hermann, 1907.) Price 7 francs.

SHORTLY after Lavoisier had presented an account of his researches on calcination to the Academy of Sciences, the French chemist Bayen discovered in the Bibliothèque royale a small volume dated 1630, in which the discoveries and views of Lavoisier were seen to be anticipated by nearly a century and a half. This volume was the "Essays de Jean Rey sur la Recerche de la cause pour laquelle l'Estain et le Plomb augmentent de poids quand on les calcine," of which a translation in English was published some years ago under the auspices of the Alembic Club (1895). By a curious coincidence, the title of Lavoisier's memoir, "Sur la calcination de l'étain dans les vaisseaux fermés et sur la cause de l'augmentation de poids qu'acquiert ce métal pendant cette opération," was almost identical with that of Rey's essays; and it is remarkable that the study of the behaviour of the same metal, tin, when calcined, led both chemists to arrive at a correct interpretation of the nature of combustion.

The salient characteristic of Rey's work is that he concentrated his attention on the increase of weight of metals during calcination, and was thus led to recognise that the air has weight prior to the investigations of Torricelli in 1643 and of Pascal in 1648. The increase of weight was explained as follows:—

"Ce surcroit de poids vient de l'air, qui dans le vase a esté espessi, appesanti et rendu aucunement adhesif, par la véhémente et longuement continuée chaleur du fourneau; lequel air se mesle avecques la chaux (à ce aydant l'agitation fréquente) et s'attache à ses plus menuës parties."

The object of the new edition of Rey's works appears to be, not so much to direct attention to the part played by Rey as chemist and precursor of Lavoisier, but to put in a claim on his behalf as the discoverer of the weight of the atmosphere and as inspirer of the later work of Torricelli and Pascal. When's Rey's "Essays" were printed in 1630 at Bazas, in a form hardly likely to attain much publicity, a copy came into the hands of a certain Frichet, a lawyer of Bordeaux, who placed the results before a circle of learned friends who assembled weekly in the rooms of the Père Mersenne at the monastery of Les Minimes, in Paris. Père Mersenne became the correspondent of Jean Rey, and, it would appear, communicated the latter's investigations to Torricelli, Galileo, Descartes, and Pascal, with whom he was in constant correspondence. Thus Rey's book "loin d'avoir été un éclair de génie inconnu, ignoré, comme on l'a supposé jusqu'ici, devient le point de départ de cette mémorable campagne scientifique qui se termina par les victorieuses expériences de Rouen et du Puy-de-Dôme."

In support of these contentions a number of letters of Jean Rey and of Père Mersenne are published, and the relationship of Mersenne with his great contemporaries traced in detail. Frémy long ago expressed the conviction that the lack of appreciation of Rey's work as compared with that of Torricelli and Pascal was "one of the great injustices committed in the history of science." The editor of the new edition of the "Essays" aims at rectifying this injustice, so that Jean Rey may take rank not merely as a chemist and first discoverer of the part played by air in combustion, but as one of the founders of modern physics.

W. A. D.

## OUR BOOK SHELF.

*Plant Anatomy from the Standpoint of the Development and Functions of the Tissues, and Handbook of Micro-technic.* By Prof. W. C. Stevens. Pp. xii+349. (London: J. and A. Churchill, 1908.) Price 10s. 6*d.* net.

ACCORDING to the axiom that the greater contains the less, there is justification for the title of the book, but so far as histology is distinguished from anatomy, the contents pertain rather to the domain of histology. This does not, however, correctly explain the nature of the subject-matter, as the author has followed the modern, and one has no hesitation in saying the best, practice of uniting the study of form and function; in fact, each chapter is devoted to a separate physiological problem. The arrangement is an excellent one for an elementary book, but it must be added that there is no attempt to rise beyond elementary facts. The difficulties of the stelar theory are avoided by reverting to the older conception of protoderm, procambium strands, and fundamental meristem. "Bast fibres," as here explained, also show a return to an older, though in this case less acceptable, definition, and the nicer subtleties of distinction between fibrous cells and wood fibres are omitted. The careful and detailed descriptions of such processes as the conduction of water and solutes through the stem will be fully appreciated, but in places the author shows but small regard for the intuitive perception of the student (*vide* figs. 56, 87, and 92). The practical examples quoted at the end of the chapters are useful, and the general presentation of the subject-matter is marked by clearness and coordination.

Following on the course of anatomy is a handbook of micro-technique. This science has been eagerly absorbed by American students sojourning in Europe, with the result that their experience has spread like leaven throughout the numerous colleges and universities in the United States. The instructions here conveyed represent the most modern and approved practice. In this country it is not the custom to push students into complex fixing and staining methods until they reach the advanced or research stage, so that it appears inconsistent to devote a third part of an elementary manual to highly technical methods. The last three chapters, on reagents and processes, microchemistry of plant products, and detection of adulterations in foods and drugs, would, if published separately, provide a most useful and attractive summary for advanced students.

*Elements of Angling. A Book for Beginners.* By H. T. Sheringham. Pp. xvi+259. (London: Horace Cox, 1908.)

We always open Mr. Sheringham's contributions to angling literature with the expectation of being beguiled by very pleasant reading, and, incidentally, of acquiring much useful information. In the case of his "Elements of Angling" we were in no wise disappointed. The book is primarily addressed to and intended for the young angler, that is, the angler young in his art, for our author will not acknowledge that any man is too old to begin; it is wide in its scope, but does not enter into so much detail as to be likely either to confuse or weary a prospective fisherman. If such a term may be excused, we would describe it as an elementary text-book of fresh-water fishing, and, like many other text-books, we think it is well worthy of study even by those well versed in the subject of which it treats.

The information and advice given are throughout of an eminently practical nature, and Mr. Sheringham is not above citing his own misfortunes as an example and warning to those whom he would instruct. Fishing for coarse fish, whether on the bottom or at the surface, is clearly and concisely dealt with, and much practical information as to gear and baits is given. The trout is discussed at somewhat greater length, and the differences in the tackle required for wet- and dry-fly fishing, together with the reasons for such differences, are clearly explained; the grayling has a chapter to itself, and, as in the case of the trout, a short but well-selected list of the flies of most general utility is given.

Exigencies of space prevent the salmon and salmon-fishing from being dealt with at great length, but this, we think, is right in the case of a fish the capture of which depends so much upon a thorough knowledge of the particular water to be fished. Care is, however, taken to direct attention to the differences between salmon and trout, whether as parr or adults, and to the difficulty which sometimes attends the recognition of a well-mended kelt and its distinction from a clean fish. While on the subject of specific distinctions, we notice that Mr. Sheringham regards the "bull-trout" as a distinct species (*Salmo eriox*), and states that it is found in the Tweed and in some rivers of the south and west; surely there is some confusion here that might well be cleared up in future editions. Last, but not least, there is an excellent index. L. W. B.

*Elements of the Theory and Practice of Cookery.* By Mary E. Williams and Katharine R. Fisher. Pp. xix+347. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1907.) Price 4*s.* 6*d.* net.

Domestic science and art, so far as they relate to cookery, are here combined to produce an educational and practical course of work. The book is not merely a collection of recipes, but a guide to the experimental study of principles and their application in the selection and preparation of food. The instructions for experiments and other work are explicit, and much good advice is given as to the conditions of healthy living and intelligent housecraft. Unfortunately, as many of the terms used in describing the utensils and ingredients required are unfamiliar in British homes and schools, the book is at a disadvantage on this side of the Atlantic, though its merits are many.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

### Spectrum of the Radium Emanation.

A few months ago, through the generosity of the Academy of Sciences of Vienna, one of us was loaned a radium preparation containing about 250 mg. of radium. Observations were at once begun to purify the emanation produced by it, and to determine its volume. An account of these investigations was read before the Academy of Sciences of Vienna on July 2. It was found that the maximum volume of the emanation per gram of radium was in good accord with that to be expected from calculation (about 0·6 cubic mm.), and the initial volume was about one-tenth of that determined by Ramsay and Cameron (Journ. Chem. Soc., p. 1266, 1907). In the course of this work we have had occasion to test the purity of the emanation by the spectroscope, passing an electric discharge in the capillary in which the volume was measured. We have on four different occasions during the last two months determined the spectrum of the radium emanation by visual observations, using a direct-reading Hilger spectroscope, leaving a more accurate determination of its spectrum until the measurements of the volume had been completed. We have now photographed the emanation spectrum, using a prism of 2 inches base. Pure emanation, corresponding to the equilibrium amount from 130 mg. of radium, was condensed by liquid air in an exhausted spectrum tube of about 50 cubic millimetres capacity, provided with thin platinum electrodes. Two photographs were immediately taken, one giving about thirty of the more intense lines, and the other, with much longer exposure, showing more than one hundred lines. For a comparison spectrum a helium tube was used. The colour of the discharge in the tube was bluish. Visual observations of the spectrum were made during the exposure of the photographs.

When the emanation was condensed in a side tube by means of liquid air, the great majority of the lines vanished at the moment of condensation, which was readily noted by the phosphorescence of the glass. The colour of the discharge then completely changed, and became of a pale rose colour. At the instant of volatilisation, the emanation lines flashed out again. The hydrogen lines were visible in the spectrum, and these became much more brilliant when the emanation was condensed. In the electrodeless discharge of previous experiments, the hydrogen lines were never observed. Their occurrence in the present experiment was probably due to the platinum electrodes. By observations of the intensity of the phosphorescence when the emanation was condensed, it was noted that the amount of pure emanation in the tube gradually diminished with increase of time of discharge. The spectrum of the emanation, however, persisted until practically all the emanation had been driven into the walls of the tube. The phosphorescence on the walls of the tube showed that the occluded emanation was fairly uniformly distributed. This effect has been observed by us on several occasions.

The first determination of the spectrum of the emanation was made in 1904 by Ramsay and Collie, who determined the wave-lengths of about eleven lines by visual observations. As shown by them, the spectrum of the emanation is a bright line spectrum with sharply defined lines. We observed also visually a weak band spectrum in the yellow, which slightly decreased in intensity when the emanation was condensed. This, however, may not be connected with the emanation itself. The wave-lengths of the lines of the photographic plate were accurately measured, using a Kayser's measuring machine. The accuracy obtained is indicated by the agreement of the wave-lengths of some of the hydrogen lines with their known values. In most cases, for well marked lines, the error is not more than half an Angström unit. The following table gives the wave-lengths of the more prominent lines. The wave-lengths of the lines initially determined by Ramsay and Collie (marked R. and C.) are added for comparison.

Visual observations of three of the more prominent lines in the yellow and green are also given:—

| Intensity | Observed λ | Remarks | Intensity | Observed λ | Remarks |
|---|---|---|---|---|---|
| 5 | 5721 | (Visual) (R. & C. 5725) | 15 | 4350·3 | |
| 8 | 5589 | (Visual) | 7 | 4340·9 | H = 4340·66 |
| 3 | 5393 | " | 4 | 4225·8 | |
| 4 | 5084·5 | | 10 | 4203·7 | |
| 4 | 4979·0 | R. & C. 4985 | 7 | 4188·2 | |
| 10 | 4861·3 | H = 4861·49 | 20 | 4166·6 | |
| 4 | 4817·2 | | 10 | 4114·9 | |
| 5 | 4721·5 | | 2 | 4102·2 | H = 4101·85 |
| 10 | 4681·1 | R. & C. 4690 | 4 | 4045·4 | |
| 10 | 4644·7 | R. & C. 4650 | 15 | 4015·0 | |
| 8 | 4625·8 | R. & C. 4030 | 12 | 3982·0 | |
| 7 | 4609·9 | | 7 | 3957·5 | |
| 4 | 4604·7 | | 4 | 3917·5 | |
| 7 | 4578·7 | | — | 3888·9 | H = 3889·15 |
| 9 | 4509·0 | | 6 | 3867·6 | |
| 10 | 4460·0 | | 10 | 3753·6 | |
| 8 | 4435·7 | | 7 | 3739·9 | |
| 6 | 4391·8 | | 10 | 3664·6 | |
| 4 | 4372·1 | | 5 | 3622·2 | |

A more detailed list of lines will be published later. We understand that Sir William Ramsay showed a photograph of the spectrum of the emanation at the meeting of the Royal Society on June 25. It will be of interest to compare the two spectra.

E. RUTHERFORD.
T. ROYDS.

University, Manchester, July 4.

### The Recent Nocturnal Glows.

THE peculiar light phenomenon at midnight on June 30, which was seen, according to the papers, on the northern part of the sky at Copenhagen, Königsberg, Berlin, Vienna, Biala, and other places, was also observed by me at Prague. At 1h. 30m. a.m. on July 1, I saw in the direction N.E. and N.N.E. a peculiar strong orange-yellow light over the horizon, the colour of which was more orange in its lower parts and more yellow in its higher parts. Its upper limit was lying twenty to thirty degrees above the horizon. The whole sky was cloudless. Other people saw it here at 11 p.m. on June 30.

It is reported that magnetic disturbances were experienced on the telegraphic lines, but I saw no trace of the characteristic auroral bands or columns. I may be allowed to add that, according to Arrhenius, this time of the year corresponds to the minimum of auroral display (activity). Interesting is the fact that a high barometric maximum was lying in the north, and that we had winds from that direction for a whole week.

BOHUSLAV BRAUNER.

Bohemian University, Prague, July 4.

### A Long-lived Solar Halo.

THERE has been visible here to-day a solar halo remarkable both for its vivid intensity and for its protracted duration. It was first noticed by me at 12.35 p.m. It then formed an unbroken ring, of which the most intensely luminous portion was to the south of the sun, and the least luminous portion to the west-north-west. Half an hour later the southern and northern quadrants of the circle were equally bright, but the northern appeared the more compact and definite; meanwhile, the eastern and western portions continued comparatively feeble, more especially the latter. *These conditions remained unchanged for fully* $1\frac{1}{2}$ *hours!* After 2.15 p.m. the northern segment of the halo was alone conspicuous, and after 3.30 p.m. the ring was never again complete, though two mock suns (to the southward and eastward respectively) still testified to the original configuration. By 4.50 p.m. nothing remained but a diffused, pale rainbow-coloured mock-sun to the north of the sun; but after 5.15 p.m. this became less indefinite, and by 6 p.m. fully a semicircle of a halo was again traceable above the sun, but this faded gradually, nothing surviving after about 6.20 p.m. The unusually strong tone of rusty orange colouring, and the conspicuous darkness of the region enclosed, made the halo an unusually striking object when at its best (12.30 to 2 p.m.).

Throughout the day cirrus cloud has strewn the sky in most interesting disorder and variety of forms. Telescopic observation of the sun's image showed (in the features of atmospheric distortion of the sun's limb) the existence of two distinct drifts of the atmosphere, viz. an upper current, *of great velocity*, passing over from the south-east above the drift from north-north-east that alone affected the local weather-cocks and chimneys' smoke. I may add that my experience as an observer of halos (both solar and lunar) has led me to the conclusion that cirrus clouds, or the conditions conducive to the formation of cirrus cloud, do not in themselves constitute the whole cause of the formation of halos, but that these are further the outcome of *cross-currents* in the region of cirrus formation.

CATHARINE O. STEVENS.

10 Woodstock Road, Oxford, June 30.

P.S.—Portions of solar halos were also seen here intermittently during July 1 and 2, thus giving a record of three successive days of halo formation.

### Genial June.

THE month just past has fully upheld its character, as it did in the Jubilee year, 1887, and on other occasions.

There were a great number of dates suitable for observation (sixteen out of the last seventeen), but I found shooting stars rare.

The nights before June 29 were, I thought, unusually dark, the stars and Milky Way being beautifully bright and distinct; but on June 30 the firmament was abnormally luminous, with a very strong glow all over the north at midnight. Few stars could be seen, and the Milky Way was hardly distinguishable. On July 1 the phenomena of the previous night were repeated in rather a different aspect. There were many clouds of various tints, and the light was again intensely strong, the northern sky being involved in a brilliant aurora. I have never seen June nights so dark, and the Milky Way so gorgeously displayed in the heavens, as this year to June 28, nor have I ever noticed the sky so bright as it appeared on the nights of June 30 and July 1.

The aurora offered so vivid a spectacle that on the dates mentioned the shades of night may be said to have been quite dispersed, for even at midnight the reflected light from sky and cloud was so strong that terrestrial objects could be seen just as at dusk, say at about 10 p.m. on an ordinary June night.

W. F. DENNING.

Bristol, July 2.

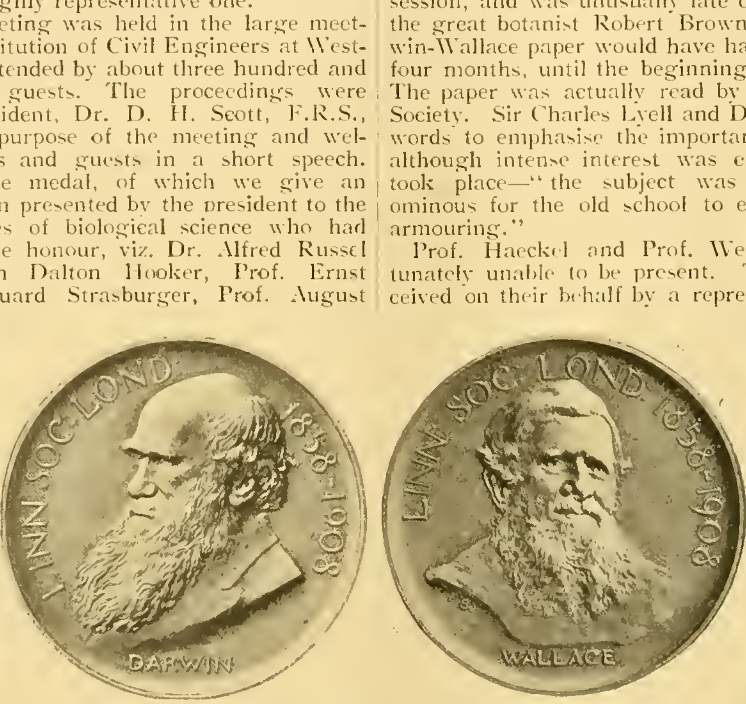
## *THE DARWIN-WALLACE JUBILEE CELEBRATION AT THE LINNEAN SOCIETY.*

ON July 1, 1858, Sir Charles Lyell and Dr. J. D. Hooker communicated to the Linnean Society a remarkable paper entitled "On the Tendency of Species to form Varieties; and on the Perpetuation of Varieties and Species by Natural Means of Selection," by Mr. Charles Darwin and Mr. Alfred Wallace. The history of this paper is familiar to every student of biology. Darwin had for many years been studying the question of natural selection and its bearing upon the origin of species, but, although his views were well known to several intimate friends, he had refrained from publishing them, and was still occupied in the collection of evidence when he received from Wallace a manuscript essay "On the Tendency of Varieties to Depart indefinitely from the Original Type," in which the same ideas were set forth. At the request of the author this manuscript, after perusal, was forwarded by Darwin to Sir Charles Lyell, with the added suggestion that the essay should be published as soon as possible. After consultation with Hooker, Darwin was induced to allow an extract from his own work on the subject to be published simultaneously.

The reading of this joint paper at the Linnean Society formed the starting point of a revolution in scientific thought the effect of which it would be impossible to overestimate, and the Society has duly recognised the importance of the occasion in the commemoration which took place last week.

A peculiarly gratifying feature of the proceedings was the presence at the afternoon meeting of Dr. Wallace and Sir Joseph Hooker, and the fellows of the society and their guests thus had the remarkable privilege of hearing an account of the great event of fifty years ago from the lips of two of the principal actors therein. The society is also to be congratulated on the very cordial response made to their invitation by the numerous universities, academies and learned societies to which it was sent, the gathering being in all respects a thoroughly representative one.

The afternoon meeting was held in the large meeting room of the Institution of Civil Engineers at Westminster, and was attended by about three hundred and fifty fellows and guests. The proceedings were opened by the president, Dr. D. H. Scott, F.R.S., who explained the purpose of the meeting and welcomed the delegates and guests in a short speech. The Darwin-Wallace medal, of which we give an illustration, was then presented by the president to the seven representatives of biological science who had been selected for the honour, viz. Dr. Alfred Russel Wallace, Sir Joseph Dalton Hooker, Prof. Ernst Haeckel, Prof. Eduard Strasburger, Prof. August Weismann, Dr. Francis Galton, and Sir E. Ray Lankester, the copy given to Dr. Wallace being in gold and the others in silver. Each medallist was addressed by the president in an appropriate speech in which his claims to the distinction were duly set forth, and all were received by the audience with great enthusiasm.




The Darwin-Wallace Medal of the Linnean Society.

Dr. Alfred Russel Wallace, in replying, spoke of the actual relations between Darwin and himself, and of the share which each had contributed to the theory of natural selection. With characteristic modesty he laid stress upon the fact that the idea had occurred to Darwin nearly twenty years before it occurred to himself. In endeavouring to explain why the same solution of the problem of the origin of species had occurred to both of them, he pointed out that a closely similar course of events had led up to the same result in each case. Both Darwin and Wallace had the passion for collecting, and both in early life had been ardent beetle-hunters. Thus they had been led to take an intense interest in the mere variety of living things and to seek for an explanation thereof. Later on both become travellers, collectors and observers in some of the richest and most interesting portions of the earth, and had forced upon their attention all the strange phenomena of local and geographical distribution, with the numerous problems to which they give rise. Then, finally, at the critical period when their minds were freshly stored with information and reflection upon the problem to be solved, both had their attention directed to the system of positive checks expounded by Malthus in his essay on population. "The effect of this," continued Dr. Wallace, "was analogous to that of friction upon the specially-prepared match, producing that flash of insight which led us immediately to the simple but universal law of the 'survival of the fittest,' as the long-sought *effective* cause of the continuous modification and adaptation of living things."

Sir Joseph Hooker, in his address, dwelt upon the considerations which determined Mr. Darwin to agree to the proposal of his friends for the joint publication of his own and Mr. Wallace's theories by the Linnean Society. He also pointed out that at the meeting Mr. Darwin was unable to be present, being himself very ill, and with scarlet fever and diphtheria raging in his family. The meeting was the last of the session, and was unusually late owing to the death of the great botanist Robert Brown, otherwise the Darwin-Wallace paper would have had to wait for at least four months, until the beginning of the next session. The paper was actually read by the secretary of the Society. Sir Charles Lyell and Dr. Hooker said a few words to emphasise the importance of the event, but although intense interest was excited, no discussion took place—"the subject was too novel and too ominous for the old school to enter the lists before armouring."

Prof. Haeckel and Prof. Weismann were unfortunately unable to be present. The medals were received on their behalf by a representative of the German Embassy, and a short address from Prof. Haeckel was read by the Zoological Secretary. Prof. Haeckel laid stress upon the importance of the theory of organic evolution, and described the foundation by himself of a new phyletic museum at the University of Jena.

Prof. Strasburger dwelt upon the influence of the Darwinian teaching upon his own career and that of Haeckel, and Dr. Francis Galton replied briefly to the president's speech. Sir E. Ray Lankester addressed the meeting at greater length, and struck a fresh and appropriate note in emphasising the share taken by Huxley in the great controversy to which the Darwin-Wallace theory gave rise. He concluded by expressing the opinion that at the present day "not only do the main lines of the theory of Darwin and Wallace remain unchanged, but the more it is challenged by new suggestions and new hypotheses the more brilliantly does the novelty, the importance, and the permanent value of the work of these great men to-day commemorated by us, shine forth as the one great and epoch-making effort of human thought on the subject."

The presentation of the medals was followed by the reception of the delegates of corporate bodies. Of the colleges and schools connected with the early training of Darwin and Wallace, Christ's College, Cambridge, was represented by the master, Dr. Peile; Shrewsbury School by Mr. C. J. Baker, chief science master, and Hertford Grammar School by Mr. G. W. Kinman, headmaster. The other bodies represented were the University of Oxford (Dr. Warren, Prof. Poulton and Dr. Church); the University of Cambridge (Dr. Francis Darwin); the University of St. Andrews (Prof.

Scott Lang); the University of Glasgow (Prof. J. G. Kerr); the University of Aberdeen (Lieut.-Col. Prain); the University of Edinburgh (Prof. I. B. Balfour); the University of Durham (Prof. M. C. Potter); the University of London (Sir W. T. Thiselton-Dyer); the University of Manchester (Prof. Weiss); the University of Wales (Prof. Phillips); the University of Birmingham (Sir Oliver Lodge); the University of Liverpool (Prof. Herdman); the University of Leeds (Prof. Blackman); the University of Sheffield (Prof. Denny); University College, Nottingham (Prof. Carr); University College, Bristol (Prof. Lloyd Morgan); the Royal Swedish Academy of Sciences (Prof. Lönnberg); the Royal Society (Sir Archibald Geikie); the Society of Antiquaries (Lord Avebury); the Royal Irish Academy (Dr. Scharff); the Manchester Literary and Philosophical Society (Mr. C. Bailey); the Royal Society of Edinburgh (Prof. D'Arcy Thompson); the Geological Society of London (Prof. Sollas); the Cambridge Philosophical Society (Dr. Harmer); the Royal Astronomical Society (Mr. Newall); the Zoological Society (Mr. Boulenger); the British Association (Sir David Gill); the Entomological Society of London (Mr. Waterhouse); the Royal Microscopical Society (Lord Avebury); the Chemical Society (Dr. Horace Brown); the Malacological Society (Mr. Byrne); the British Academy was represented by Sir E. Maunde Thompson.

Dr. F. Darwin and Sir W. T. Thiselton-Dyer spoke on behalf of the universities and schools, and Prof. Einar Lönnberg and Sir Archibald Geikie on behalf of the academies and societies represented. Prof. Lönnberg announced that his gracious Sovereign, His Majesty King Gustaf of Sweden, had ordered him to convey to the Linnean Society his hearty greetings and sincere felicitations on this occasion. He also presented a very beautifully illuminated address from the Royal Swedish Academy of Sciences, and a silver copy of the Linnean medal of the Academy struck in commemoration of the Linnean celebrations of last year. Several other addresses were also presented by the delegates.

The concluding speech of the afternoon was delivered by Lord Avebury, who described, in an extremely interesting manner, his own intimacy with Charles Darwin, laying especial emphasis upon his peculiarly amiable personal character and upon the devotion shown by Mrs. Darwin to her husband and children. He referred to the quiet life at Down, and told the delightful story of one of Mr. Darwin's gardeners, who thought it was such a pity that his master had not got something to occupy him, for he wandered about the garden doing nothing, and would stand for as much as ten minutes at a time gazing at a flower!

After the afternoon ceremony, ninety of the fellows and their guests dined together at the Princes' Restaurant, the party including Sir George and Lady Darwin, Dr. F. Darwin and Mr. W. E. Darwin, while foreign biologists were represented by Profs. Hubrecht, Lönnberg, Strasburger and Warming. There were no speeches, and at nine o'clock the company adjourned to the rooms of the Linnean Society at Burlington House, where a reception was held by the president and Mrs. Scott. Two short lantern lectures were delivered during the course of the evening, one by Prof. Seward on "The Jurassic Vegetation of the World: a Study in Plant-migration," and the other by Dr. Smith Woodward, on "The Evolution of Mammals in South America." Various exhibits especially appropriate to the occasion were also shown in the library. Amongst these were a beautiful series of insects from the Hope collections in the Oxford University Museum, exhibited by Prof. Poulton and Mr. J. C. Moulton, in illustration of the phenomena of mimicry and variation. Other collections of insects illustrating special points connected with the theory of evolution were exhibited by Dr. Dixey, Col. Manders, and Dr. Longstaff; while Mr. R. A. Rolfe exhibited some beautiful flowers of natural hybrid odontoglossums with their parents.

We believe the Linnean Society intends to publish a full account of the proceedings, together with the addresses and speeches, which should form an extremely interesting record of a very impressive and memorable occasion.

A. D.

## THE DAYLIGHT SAVING BILL.

If anyone is in search of an object-lesson in the necessity for the introduction of some science into general education he will do well to give his attention to the proceedings in connection with the Daylight Saving Bill. He will probably find therein so much confusion of thought that he will feel some training in clear thinking to be imperatively demanded, though there is an off chance that he will be depressed beyond recovery by the contemplation of the report of the Select Committee on the bill which appeared in the newspapers on July 3.

To begin with the original short title—the Daylight Saving Bill—it will be conceded that no action of Parliament will produce any effect upon daylight. One may save gas or electric-light, and make more use of daylight, but to talk of "saving daylight" is metaphor intelligible enough for ordinary purposes, but not suitable for legislation. When a legislative act begins with metaphor it is not matter for wonder if it eventuates in allegory, and sooner or later that must be the end of the bill.

It would conduce to greater clearness if we knew exactly what is "the principle of the bill." It is designed to make every item in "the trivial round and common task" happen an hour earlier in the summer months than in the winter, but it does not propose that. It proposes the ingenious and apparently simple expedient of moving the clocks on an hour in April and back again in September, and it is assumed that the other will be a natural consequence. Whether the purpose or the proposal of the bill constitutes its principle has never been stated. The confusion of ideas is most insinuating; a person who approves of earlier hours in summer is quite likely to find himself committed to the "principle of the bill." When the Astronomer Royal was under examination before the Committee the confusion was most evident to the looker-on. The witness was definitely opposed to any alteration of the clocks, and yet seemed to suggest that the proposal of the bill should be referred to working men. The question that he wished referred was whether they desired to be made to get up an hour earlier in the morning than they do now—there is no such proposition in the bill—not whether the designation of a particular hour of the day should be five or six—but that is in the bill and nothing else.

Cross-examination by members of the Committee turned largely upon this confusion about the principle of the bill, and upon a further confusion of ideas between having different time standards in different geographical localities and different time standards in the same locality at different times of the year. The reasoning which implies that if the one is found to be practicable objection to the other must be merely indolence or conservatism would be really worth analysis at any time of the year except the dog days. Take an example under the bill. Standard Greenwich time is to be kept for astronomical and for navigation purposes, and standard Irish time is also to be undisturbed; but "local" time is to be established in Great Britain and Ireland an hour in advance of standard time. A steamer is announced to leave Dublin at half past twelve every night, Sundays excepted. What will the announcement mean?

There are already two interpretations. Only experience can tell whether it means 12.30 or 12.55 a.m. G.M.T.; but with the permission of the bill there will be four times which will be legal tender for this denomination, viz. 11.30 p.m., 11.55 p.m., 12.30 a.m., 12.55 a.m., G.M.T., and any one of them may be understood or misunderstood in the circumstances.

The tone of the Select Committee's report indicates that it thinks confusion between these four times will be obviated with a little practice, and if not, the number of people who travel from Dublin is so small compared with the number of those who do not that they can be disregarded.

Some ingenious advocate of the bill has endeavoured to justify it by a confusion of ideas which finds an analogy between the zone adjustment of standard time for longitude and changing the nominal hour of noon as an adjustment for latitude. The double-edged nature of the false analogy appears to have been overlooked. If sunrise is earlier, sunset is later, and if 11 should be called 12 on account of the earlier sunrise, *ex equali* 1 should also be 12 on account of the later sunset; this kind of argument, hollow as it is, has misled a newspaper, generally intelligent, into the grave error of accusing Scottish clocks of "lying" because the time of sunset in the far north, as recorded by them, differs by an hour from the scheduled time of sunset for Greenwich! What sort of clock would the leader writer of the *Westminster Gazette* prescribe to tell the truth in latitude 70°, where at certain times of the year there is no sunrise and at others no sunset?

There is a further delightful confusion about the bill not being compulsory which enables its advocates to ride away from all sorts of difficulties by explaining that if you find it inconvenient you can use Greenwich time as now. In the report they dispose in that way of the difficulties of American business as well as those arising in connection with astronomical, nautical, and scientific work. Any occupation which uses self-recording instruments can also be disposed of quite easily by calling it scientific and allowing it the liberty which, according to the promoters, is not infringed by the act.

What does this liberty mean? By establishing "local" time without compulsion, are either or both local time and Greenwich time to be legal? And if so, at whose option? May the North-Western Railway adopt the act and the Midland decline? And must the option be exercised once for all at 2 a.m. on the third Sunday in April? or can any person change his mind afterwards? Can anyone legally claim to go to business by Greenwich time and then revise his opinion and demand to leave by local time? Possibly the advocates of the bill are acting upon the assumption that the convenience of the new time will assert its own compulsion as Greenwich time has done, in every town in Great Britain except the ancient city of Canterbury. If it does it will be for some other reason than that which has been so effective in the case of Greenwich time.

The confusion is worse confounded by the report of the Select Committee. The new time is to be called local time, and the short title of the bill is changed; it is now called the "Local time (Great Britain and Ireland) Bill." What kind of confusion are we in now! We thought we knew what local time meant. But between the third Sunday in April and the third Sunday in September we are to have the option (there is no compulsion in the bill) of keeping our clocks at local time, and then 5 p.m. as by law "established" will be, we suppose, five hours after local noon, or should it be five local hours after noon and four, or is it six, hours after Greenwich mean noon? Local time must not be confused with middle European time, though the figures will be identical; that is disapproved by the report.

After an elaborate inquiry, which included a prolonged consultation with the Astronomer Royal, the Committee seems to have lost sight of the fact that local time has already a perfectly definite meaning, and connotes a time measurement based on "local noon," which is late on Greenwich noon, not an hour in advance of it, as the revised bill declares, for nearly all places in Great Britain and Ireland.

It seemed incredible at the outset that serious men of business should really confuse themselves between altering the clocks, which was the proposal, and altering the time of occurrence of events, which was the purpose. It seems more certainly incredible that after prolonged inquiry the Committee should have failed to understand that local time has already a meaning, and cannot, even by Act of Parliament, be made to connote middle European time during the summer months. Yet that is the effect of the bill in its revised form.

If this new definition of local time is final, the report, which originated with metaphor, cannot, after all, be more than allegory; but what lesson the allegory is intended to convey is still a mystery.

What has tickled the fancy and captivated the imagination of the advocates of the measure is that since the introduction of telegraphs and standard time the control of clocks from Greenwich is so completely organised that its very existence is unknown to, perhaps, ninety-nine people out of a hundred, who have come to regard clocks as final timekeepers instead of Greenwich mean time. If this control, which works so smoothly and so surely, were modified so as to make clocks skip an hour in April, every subsequent event would be made an hour earlier, and yet we should be using the same Bradshaw and the same Postal Guide. The apparent simplicity and the completeness of the operation are very attractive. But one would suppose that the operation would at least require the connivance and active assistance of the controllers of all the clocks, certainly those of all the public clocks in Great Britain and Ireland. That the promoters know to be impossible, so, by the bill, the change is imagined to take place—it cannot actually take place—in the deadest of the dead of night, when there will be practically nobody to see that the clocks are not moved. This, again, is curious in an Act of Parliament. To prescribe that a certain operation shall take place at a time which has been selected because presumably there will be fewer people in a position to carry out the order than at any other time, is fine allegory but bad legislation.

Herein is further confusion of ideas arising from the notion that if an order is given to alter the clocks subsequent events will be thereby accelerated. Subsequent events may be accelerated, but it will be in pursuance of orders to accelerate them. It is inconceivable, for example, that such a body as that which controls the North-Western Railway will be content to alter the clocks in the dead of night and expect all subsequent events advanced an hour without express orders given to everybody concerned to accelerate by an hour whatever he has to do on Sunday, or for the large majority on Monday morning. In that case it is clear that the operative cause lies in the orders given, and not in the alteration of the clocks, which is a mere trivial circumstance, and might be omitted without any diminution of the effect of the orders. In like manner you may inform a post-office official that you are going to alter his clock to-morrow morning, but unless you make it clear to him at the same time that he has got to be at work an hour earlier he will certainly regard your time-keeping with aloof interest. Anybody who has the real authority to order the day's work to begin earlier will not care much about altering clocks.

Nor is it likely, as the Committee seems to think, that because Parliament may decide to change the denomination of the hours they will thereby change the meaning of all the statutes in which hours are mentioned. To assume that public houses will regard themselves as closed an hour earlier because the clocks are moved leaves out of account the ingenuity of those who are affected. Our lawyers have not altogether lost their cunning; indeed, the bill might have been promoted by one of that profession, for there will be delightful opportunity for argument as to whether 12.30 a.m. "local" time (= 11.30 p.m. G.M.T.) is to-day or yesterday, and as to which of the two 12.30's is in the forenoon. What, indeed, shall we do with such appendages as noon, a.m., and p.m.? Will the denominations run 11 a.m., 12 a.m., 1 noon, 2 p.m., and so on? If so, 12.15 a.m. might become quite an interesting time for a lawyer.

Into this whirl of confusion of ideas it seems hardly safe to entrust a few timid scientific considerations. That we should have a system of keeping time under which, in spite of all principles of continuity of measurement, the numbers between 2 a.m. and 3 a.m. on the third Sunday in September will be travelled over twice, and the same numbers will have different meanings, would be roughly brushed aside by the remark that as nothing happens between 2 and 3 on the third Sunday in September it does not matter. It is the bold assurance of knowledge of the important and the unimportant which strikes the cautious scientific observer with a cold shudder. On the staircase leading to the committee room where this document has been evolved there is an inscription to the effect that copies of the imperial standards of length and weight are built into the wall to make sure that they shall never again be lost through fire. Reading this in passing, one carries away an impressive idea of the sanctity of standards, to find that in the committee room such an idea is regarded as quite early-Victorian. If it would make things more comfortable for a majority of the electors to have an inch off the standard yard, why not have it off? The yard is there; you have only to dig it up. There is no difficulty about it. Those people who would be inconvenienced can use the old yard if they like, and, anyway, they do not count.

What is true of the immured standards, the result of prolonged labour of a Royal Commission, is equally true of the time standard which represents generations of eminently successful work at the Royal Observatory. Yet how can one convey to legislators that a fluctuating standard is unscientific, and that by scientific one means suitable for general acceptance, and for permanent use, and not merely suitable for a few persons of special occupation and training? Are they only to be convinced by the method of trial and failure, the crudest, the most childish of all methods, that the relations of science and practical life are indescribably numerous; that if they adopt a scheme of time designation that has no scientific basis it must result in failure, however bold its promoters may be in rejecting eighths or neglecting quarters: that the advance from the "local" time of fifty years ago to "standard" time of to-day was a step well thought out, and one that cannot be reversed by the introduction of a new and really nondescript time under the old name?

Of course, there remain the great salient objects, the earlier hours of work in summer combined with the undisturbed Bradshaw and the continuity of the Postal Guide. Compared with these the continuity of time measurement is dismissed as a slight matter of no importance to practical people, a piece of scientific pedantry. But let it be remembered that the whole structure which Bradshaw and the Postal Guide represent has been reared upon the basis of an unalterable standard time, and that not even the most experienced legislator can follow out the consequences of taking out the corner-stone of that structure.

In the meantime there is plenty of room for the activity of reformers in the direction of earlier hours. It may be noticed that a large majority of workers, both in town and country, whose work does not depend upon facilities for correspondence, already commence work at 6 a.m., and for them noon is the central hour of the day. The latest people are the office people, who wait for their letters to be sorted. In these days of competition, if there is an early worm anywhere the early bird will not be very far off, and attendance is governed by facilities. It is a curious fact that, although early train facilities are so plentiful and so cheap, except on Sundays, that many clerks come to London in advance of their business hours because they can take advantage of them, there are only two post offices in the London area open for the transaction of telegraphic business before 8 a.m. on Sundays and barely a dozen on week days; in the country districts there are none. Early telegraphic facilities are formulated upon quite the opposite principle from that of workmen's trains; they are very expensive. Yet anyone blessed with a neighbour who is engaged in having his house built, altered, repaired, or painted will be aware that 8 a.m. is a very belated shot at the commencement of the working day. The conclusion that one comes to is that the number of people for whom postal and telegraphic facilities are matters of business, and who therefore keep late hours, are relatively few. To change the hour of work for the millions who begin at six in order to give the thousands that begin at 10 an extra hour of daylight, which is already theirs if they like to use it, seems no more reasonable than to disregard the requirements of Continental correspondence, as the Committee does, because it is only one-eighth of the whole.

Finally, there is another quite interesting confusion of ideas about the purpose of the bill. Its promoters are sanguine that when it is passed there will be longer use of daylight for outdoor sports and exercise with the same time for work, recreation and sleep as before, and yet the day is to remain twenty-four hours.

For most people the days are pretty full already. "Six days shalt thou labour and do all that thou hast to do" is a commandment which many people find it very hard to keep. To put in an extra hour's occupation in the day would not be possible for them. To make up for the light hour saved, a dark hour ought to be cut off.

When the bill is in operation there will be exactly the same interval between leaving off work and the commencement of the "halls" as before. If the workers take advantage of the extra hour of daylight for open-air recreation, which comes to them as a sort of free gift by a manipulation of the clocks, it is much to be feared that there will arise a strong temptation to crowd the day, already so overcrowded that no time is left for such an occupation as reading, with an additional hour of glorious life reckless of the loss of health and strength that, in the long run, follows insufficient sleep. In spite of the prolonged inquiry, the Committee's proposal, although it is ostensibly an appreciation of daylight, appears to many persons, and those not all indolent or conservative, to be nothing more or less than a proposal for a leap in the dark.

## WOMEN AND THE FELLOWSHIP OF THE CHEMICAL SOCIETY.

THE women, like the Peris at Heaven's Gate, have knocked at the door of the Chemical Society and have asked to be let in. Their request, as will be seen from the correspondence which we print below, has been referred to the whole body of the fellows, and there are those among them who are much perturbed in consequence. The more excited ones, we understand, are all for banging, barring and bolting, unmindful of the portents that a banging, barring and bolting policy is nowadays a bit discredited. Others, and we trust, for the fair fame and credit of the society as a scientific organisation, that they are the majority, are of opinion that the time has come when its fellowship should be rendered accessible to women. At least, so say the 312 fellows (including 10 past presidents, 12 vice-presidents, and 29 members of council, past and present), among whom are 33 Fellows of the Royal Society, and the heads of the chemical departments of nearly all the most important universities and colleges in the kingdom, who have now moved the council, by the most influentially signed memorial that body has ever received, to consent to the referendum.

It is difficult to know on what grounds the admission of duly qualified women to the society should be refused. Those who desire admission have been adequately trained in science, and most of them are graduates. They are, as pointed out by Sir Henry Roscoe in a letter to the *Times* of July 3, *de facto* chemists, engaged either as lecturers or demonstrators of chemistry in various schools or colleges throughout the country; some of them act as research assistants to professors of chemistry, or cooperate with them in the work of original inquiry; one or two are employed as works-chemists. The objects of the Chemical Society are defined to be the promotion of chemistry, and of those branches of science immediately connected with it, by the reading, discussion, and subsequent publication of original communications. It cannot be denied that women have contributed their fair share of original communications. Indeed, in proportion to their numbers they have shown themselves to be among the most active and successful of investigators. The society consents to publish their work, which redounds to its credit. Why, then, should the drones who never have done, and never will do, a stroke of original work in their lives be preferred to them simply because they wear a distinctive dress and are privileged to grow a moustache?

The women-chemists will doubtless smile at the futility of the adverse arguments which appear above the names of the two honorary secretaries of the society. They will have their own opinion concerning the arduous nature of chemical work, about which they know quite as much as those who profess so tender a solicitude for them. As to their chances of success in life, they have shown that they are quite able to hold their own, in spite of the alleged "overcrowded state of the profession." Overcrowded state of the profession, forsooth! With a delicious but wholly unconscious *naïveté*, the banging, barring and bolting people have herein revealed the true inwardness of their opposition. It is the argument of the weak-kneed—of persons whose *Zunftgeist* has warped their judgment and disturbed their mental balance. We trust the main body of the society will treat the argument with the contempt it merits. It is astonishing how unscientific some so-called scientific persons can be. Apparently they fail to perceive that this request on the part of qualified women to be permitted to share the benefits and material advantages which arise from the cooperation of scientific workers in a common calling is the natural and logical result of affording women facilities for the cultivation of science in practically every university in the country. The study of science, even professionally, is no longer the exclusive prerogative of men. It was inevitable that among the many hundreds of women who are now passing through these universities, or through colleges in close association with them, there should be some who are attracted to science as a calling, or who should find in its pursuit a congenial occupation. They are surely entitled to make their own choice of their life's work. Why, then, should obstacles be thrown in their way? They ask for no favour—only for fair play and fair treatment, and it is the banging, barring and bolting people who, from unworthy motives, would deny them both.

A perusal of the correspondence which we publish below, and especially of the significant letter of the past presidents of the society accompanying the memorial addressed to the council which they have caused to be distributed to the fellows of the society, indicates pretty clearly to what lengths certain individuals are prepared to go in resisting the claims of the women. The memorial, it will be seen, expressed the personal opinion of the 312 signatories that the time had come when the fellowship should be rendered accessible to women, but that weighty fact is not mentioned in the letter which appears above the names of the secretaries. This was neither fair to those who signed the memorial nor to the women whose cause they had taken up. It is possible that this *suppressio veri* was unintentional, nor is it likely, we imagine, that there is any *arrière pensée* in the redundant words to which the past presidents direct attention and which serve only to confuse the issue. But those who drafted the letter and the accompanying ballot-paper must at least be held responsible for the bungling, maladroit manner in which the matter was presented to the fellows. It is a question for the society whether its true interests would not be better served by the transference of its secretarial business to more competent and more judicious hands.

*Letter from the Secretaries of the Chemical Society to the Fellows.*

BURLINGTON HOUSE,
PICCADILLY, W.
*June*, 1908.

DEAR SIR,

The Council of the Chemical Society have received a petition praying for an inquiry as to the views of the Society as a whole on the question of admitting women to the Fellowship.

Accordingly, the Council invite very careful consideration of the following brief statement of the chief arguments which have been used both for and against the admission of women.

It is proper to point out that the Council were advised on a former occasion by Counsel that there is some doubt whether, under the existing Charter, women are admissible as Fellows; it is also well to remember that if admitted to this status, women would be eligible, like other Fellows, for a seat on the Council and to hold office.

Those who support the view that steps ought to be taken in order to provide for the admission of women to the Fellowship point out—

(1) That the petition has been signed by 312 Fellows (including 10 Past Presidents, 12 Vice-Presidents, and 29

Members of Council, past and present), among whom are 33 Fellows of the Royal Society and the Professors of Chemistry or Heads of Chemical Departments of nearly all the most important Universities and Colleges in the country.

(2) That a number of women are now devoting themselves to the science of Chemistry, the study of which it is the chief object of the Chemical Society to promote. It is shown that they are capable of independent work by the facts stated in the petition; moreover, in the Transactions from January to May this year there are four papers by women authors independently of others in which they appear as joint authors.

(3) The Chemical Societies of Berlin and America and the Institute of Chemistry admit women to full privileges of membership. The Chemical Society itself has placed the name of Madame Curie among those of its Honorary Members.

(4) A small number of women chemists attend the meetings of the Society regularly as visitors, and no inconvenience has arisen from their presence. They ask that they should be admitted in order that, in addition to exercising the voting powers, they may use the Library and receive the publications of the Society on the same terms as Fellows; at present they have to pay the higher price of publication charged to the general public.

(5) The Society numbers more than 2800 Fellows, while the number of women desiring admission at the present time is about 20; this number will probably increase as time goes on, but judging by the experience of other Societies, it is not likely greatly to exceed that number in the present generation. Should the number rise to as many as 50, their numerical strength would remain wholly insignificant in regard to the conduct of the Society's affairs; consequently, any fear that female influence might hereafter dominate the Council, or even that one woman might be elected to the Council except only in recognition of her scientific ability, is not worth consideration. As to the undesirability of substituting one sex for another in offices of employment, little argument can be based on such a consideration so long as men continue to hold many of the teaching posts in women's colleges.

(6) There is reason to believe that in the event of a decision in favour of applying for a supplemental Charter, the cost, or a large part of it, would be borne by the women chemists and their friends.

On the other hand, those who are unwilling to admit women to the Fellowship of the Chemical Society urge that—

(1) The expense, probably amounting to several hundred pounds, which would be incurred by the Society if a supplemental Charter is necessary, is not justified by the small number of new Fellows likely to seek admission.

(2) It may be gravely doubted whether the deliberate encouragement of women to enter the chemical profession would not operate unfavourably on women themselves in view of the arduous nature of chemical work.

(3) Although it is true, as urged by supporters of the petition, that the number of women seeking admission is small, it is also claimed as a reason for admission that the volume of chemical work contributed by women is increasing rapidly. So long as the women who desire admission remain in such disproportionate minority, there will be an inevitable—although, of course, involuntary—tendency to overestimate their contribution to chemical knowledge and practice. An illustration of this principle may fairly be drawn from the petition itself, where figures are adduced to show that during the past thirty-five years women have been associated with 103 Papers contributed to the Transactions of the Society, but it is not stated, though equally true, that while the total number of Papers printed during that period exceeds 3400, only twenty-three are in the names of women alone.

(4) Even assuming that these 23 contributions were independent of masculine inspiration, it may be questioned whether women have, as a group, shown marked aptitude for chemical pursuits, particularly when it is recalled that the authors in question have worked almost exclusively in collegiate institutions.

(5) Moreover, by being welcomed as guests to the Society, women have been able to enjoy that chemical atmosphere and intercourse which Fellowship of the Society involves.

(6) As regards the admission of Madame Curie to Honorary Membership, it must be borne in mind that Honorary and Foreign Members have no voting powers, and are not eligible for office.

(7) Briefly stated, the position of those unfavourable to the admission of women is that, whilst gladly offering to those women who already have become chemists measures which would give them the benefits derived from attendance at the meetings, they deem it inexpedient publicly to encourage women to adopt chemistry as a professional pursuit, since such a course would tempt them into a career in which they may ultimately not find employment in view of the already over-crowded state of the profession.

Other minor considerations might be mentioned on both sides, and rejoinders to all the above statements are generally obvious. The Council therefore hope that every Fellow will carefully consider the arguments on both sides, and give them the weight which each, respectively, appears in his judgment to deserve.

You are requested, after making the necessary deletion, to return the enclosed ballot paper to the Secretaries in the accompanying envelope, which envelope must be endorsed with your signature. *Unsigned envelopes and signed ballot papers will be invalid.*

The ballot will close on the first day of October next.

We are, Sir,
Yours faithfully,
M. O. FORSTER,
ARTHUR W. CROSSLEY.
(*Hon. Secretaries.*)

*Letter from Past Presidents communicating the Memorial to the Fellows.*

OXFORD,
*1st July*, 1908.

DEAR SIR,

In the letter, which has been sent by the Secretaries of the Chemical Society to every Fellow, on the question of admitting Women to the Fellowship, reference is made to a petition received by the Council. We think it desirable that the petition itself, which is not only a petition but a declaration of opinion on the part of a large body of the Fellows of the Society, should be made known generally, together with the names of those by whom it was signed. Accordingly we enclose herewith a copy of the petition as presented to Members of the Council.

Before the issue of the voting papers the attention of the Secretaries was called to an ambiguity which is due to the introduction of the words "the full rights and privileges of." We suggest that those Fellows who are in favour of the admittance of women to the Fellowship, and not only to "the full rights and privileges of the Fellowship," should strike out these words. It would clearly be possible, however unreasonable, to create a class who, though not actually Fellows, were admitted to all the rights and privileges of the Fellowship. That such a class should be created is not the question which the Council were asked and consented to put.

We are, Sir,
Yours faithfully,
(*Signed*)
WILLIAM ODLING.
WILLIAM CROOKES.
A. VERNON HARCOURT.
HENRY E. ROSCOE.
HUGO MÜLLER.
W. J. RUSSELL.
T. E. THORPE.
J. EMERSON REYNOLDS.
WILLIAM A. TILDEN.
R. MELDOLA.
ALEX. CRUM BROWN.

*Memorial addressed to the President and Council of the Chemical Society.*

GENTLEMEN,

We, the undersigned Fellows of the Chemical Society, being of opinion that the time has come when the Fellowship of the Society should be rendered accessible to women, request the Council to take such steps as may appear desirable to ascertain the wishes of the Society as a whole in regard to this question.

We understand that there is now an appreciable and increasing number of women of University training engaged in advanced teaching, and in original investigation in chemistry, who desire admission to the privileges of the Fellowship, and as the Chemical Society was founded for the advancement of Science, it seems to us neither just nor expedient that a body of highly qualified workers should be excluded solely by reason of sex.

From the following table, compiled from the Society's journal of the past 35 years, it will be seen that the number of Papers contributed either alone, or jointly, by women is increasing rapidly :—

| | No. of papers published in Proceedings | Transactions |
|---|---|---|
| 1873–82 | 2 | 2 |
| 1883–92 | 7 | 7 |
| 1893–02 | 45 | 33 |
| 1903–07 | 66 | 61 |

We may further point out that not only have women contributed original memoirs to these publications, but they have rendered valuable service to the Society as abstractors and in the compilation of the Indexes.

As is well known, the Chemical Societies of Berlin and America, the Society of Chemical Industry and the Faraday Society, admit women on the same terms as men, and our Society has found a place for Madame Curie among the Honorary and Foreign Members: we consider, therefore, that the restriction should be removed under which the Chemical Society denies to women chemists the advantages extended to them by the sister Societies at home and abroad.

We are, Gentlemen,

Your obedient Servants.

Here follow the names of the 312 Fellows (including 10 Past Presidents, 12 Vice-Presidents and 29 Members of Council, past and present), among whom are 33 Fellows of the Royal Society and the Professors of Chemistry or Heads of Chemical Departments of nearly all the most important Universities and Colleges in the country.

## *NOTES.*

In connection with the celebration of the tercentenary of the birth of Evangelista Torricelli, an exhibition will be held at Faenza from August 15 to October 15. Included in the programme, and associated with an international section for physical apparatus, in celebration of Torricelli, a prize of 2000 lire is offered for an instrument in connection with meteorology or physics of the earth. The instrument must be exhibited, and show real novelty, either in its principle or in its application of a principle already known. For further particulars application should be made to Dr. W. N. Shaw, F.R.S., Meteorological Office, 63 Victoria Street, London, S.W.

From July 1 the morning hour of observation in the British Isles for the Daily Weather Report of the Meteorological Office has been changed from 8 a.m. to 7 a.m., and that of the midday observation from 2 p.m. to 1 p.m. At only two of the twenty-nine stations have the earlier observations been found impracticable. Simultaneously, arrangements have been made for the transmission of the telegraphic reports from all the stations, except one, at which the early observations are made, and for attendance at the office in Victoria Street at the same hour to receive the messages. It is anticipated that the revised arrangements, by which the observations in this country become synchronous with those of France, Belgium, Holland, Germany, Denmark, Iceland, Norway, and Sweden will lead, when fairly established, to a considerable acceleration of the morning reports.

Brilliant sky-glows were observed in many different parts of the United Kingdom on the night of June 30 and on several succeeding nights, the phenomenon being apparently at its maximum intensity on the night of July 1. The whole of the northern part of the sky, from the horizon to an altitude of about 45°, and extending to the west, was suffused with a reddish hue, the colour varying from a pink to an Indian red, whilst to the eastward of north the colouring was distinctly a pale green. No flickering or scintillation was observed on the reddened sky, nor was there any tendency to the formation of the streamers or luminous arch characteristic of auroræ. Cirro-stratus clouds near the horizon were tinged with the same colour as the surrounding sky. A special feature in connection with the phenomenon was the prolongation of twilight, extending almost to the following daybreak, and from the experience cited by many observers in various parts of Great Britain the light at midnight was sufficient to allow of fairly small print being read without any aid from artificial light. These nocturnal glows were preceded by a drought extending in London, as well as in several other parts of England, to about sixteen days, and it was followed by severe thunderstorms on the night of July 3 and on the succeeding day. The fine weather in many parts of the country has, however, remained unbroken, so that no relation between the display and disturbed weather can be claimed. Miss C. O. Stevens, who describes a long-sustained solar halo in our correspondence columns, made observations of the coloured skies on the nights of June 30, and July 1 and 2, until daybreak obliterated them. She says :—"The naked-eye evidence favours the view that the phenomenon was due, in part at least, to auroral display, both in the brilliant white and delicate green patches of light that were of rather inconstant brilliance, and in the spreading of the rosy light into the far south and south-west at 1.45 a.m. on July 1." We are informed, however, that spectroscopic observations failed to give any evidence that the phenomenon was auroral in character.

The death is announced, at the age of eighty-four, of Prof. J. V. Barbosa du Bocage, director of the Zoological Institute at Lisbon.

The death is announced, in his seventy-third year, of Prof. C. Schrader, the leading authority in Germany on the Assyrian language and Assyrian civilisation.

The prize of 10,000 francs (400*l.*) offered by M. Armengaud to the first aëroplane to remain in the air for a quarter of an hour was won by Mr. Farman on Monday, at a competition held at Issy-les-Moulineaux, under the auspices of the Aéro Club. Mr. Farman made a flight with his apparatus which lasted 20m. 20s. according to the official timing. He covered a distance of about eleven miles.

Count Zeppelin last week made a remarkably successful flight in his new airship. The airship started on its voyage from Friedrichshafen at 8.30 a.m. on July 1, and headed for Switzerland. After executing evolutions over Lake Constance, the airship proceeded in the direction of Lucerne, where it was seen at 12.30 p.m. The return northwards was over lakes Zug and Zürich, and the airship was observed over the town of Zürich at 2.20 p.m. The airship's floating shed on Lake Constance was reached at 8.30 p.m. The distance covered is estimated at 250 miles, and the journey lasted twelve hours. The greatest height reached by the airship's own engine-power is stated to be some 750 metres, and the highest speed 15·3 metres per second. It will be remembered that the previous record voyage of Count Zeppelin was in September last, when the airship was in the air for eight hours and a half. We notice that Count Zeppelin has received a telegram of congratulation from the German Emperor.

THE Institution of Electrical Engineers has bought the unexpired lease of seventy-six years of the Medical Examination Hall, on the Victoria Embankment, from the Royal College of Physicians and the Royal College of Surgeons. The purchase price agreed upon is 50,000*l.*, the annual ground rent being 2201*l.* The Institution of Electrical Engineers will take possession of their new premises on June 1, 1909. It is expected that the building will provide adequately for the needs of the institution, and afford suitable accommodation for its library.

THE Antarctic Expedition, which is to leave shortly under the leadership of Dr. Jean Charcot, has, according to the *Globe*, been granted a subsidy of 24,000*l.* by the French Government. Dr. Charcot's vessel, the *Pourquoi Pas*, has been specially built for ice work. The party will include a biologist, a meteorologist, two astronomers, and several naval officers. Dr. Charcot expects to be away two years. Coal will be taken in at Punta Arenas, and the base of the operations in case of need will be the island of Port Charcot, where the leader spent a year in 1903. It is interesting to note that it is intended to take two motor sledges on the expedition.

A REUTER telegram states that Commander Peary left in the *Roosevelt* on his expedition to the North Pole on July 7. The *Roosevelt* has been provisioned for three years, although her commander hopes to accomplish the journey to the Pole and back in half that time. At Whale Sound Commander Peary will take on board twenty-five Eskimo hunters and dog drivers with their families, making between forty and fifty persons. The expedition will require from 200 to 250 dogs. Commander Peary hopes to accomplish the object of the expedition and return by October, 1909. For winter quarters he will endeavour, a *Times* correspondent states, to force the *Roosevelt* to the same point on the north shore of Grant Land that he occupied in the winter of 1905–6. Commander Peary only lacks 1000*l.* of the 10,000*l.* needed to equip the ship adequately for a two years' voyage.

THE first international congress concerned with questions of the production of low temperatures and their application to industrial and sanitary purposes is to be held in Paris from October 5–10 next. The congress is being assisted by the French Government, by several municipalities, by commercial companies, and other bodies. The programme which has reached us shows that the business of the meetings will be transacted in six sections, dealing respectively with the following subjects:—section i., low temperatures and their general effects, president, Prof. d'Arsonval; section ii., freezing mixtures and machines, president, Prof. H. Leauté; section iii., application of low temperatures to foods, president, M. A. Gautier; section iv., application of low temperatures to other industries, president, M. E. Tisserand; section v., applications of low temperatures to commerce and transport, president, M. Levasseur; and section vi., legislation, president, M. J. Cruppi. The sections are subdivided somewhat minutely, and the specialist will have every opportunity of acquainting himself with modern views of every aspect of the subject. The general president of the congress is M. André Lebon, and the general secretary M. J. de Loverdo, 10 rue Denis-Poisson, Paris (17e).

IN the House of Commons on Monday, Sir E. Sassoon asked the President of the Board of Trade whether his attention had been directed to the issue of the report of the Select Committee on the Daylight Saving Bill, and, if so, whether the department had expressed any opinion relative thereto. In reply, Mr. Churchill said:—"I have read the report of this committee with much interest and with a lively recognition of the advantages which the Bill in question appears at first sight to offer to all classes, and especially to the working classes. I have arranged for the whole subject to be carefully examined by the Board of Trade in consultation with representatives of trade, labour, and transport interests. Pending the result of this examination it is not possible for me to express an opinion." We refer elsewhere in the present issue to some of the objections to this proposal to juggle with time-keepers. In rural industries the hours of work are adapted to hours of daylight at different seasons of the year, and this is also the case with workers in building and engineering trades. The proposal to legislate for national self-deception in time reckoning because of the late hours now kept in cities is as unscientific as it would be unworkable. It would be just as reasonable for Parliament to decide that a temperature of, say, 50° should be called 40° in summer and 60° in winter.

THE death is announced, from Berlin, of Prof. Oskar Liebreich, the pharmacologist, in his seventieth year. We learn from the *Times* that Prof. Liebreich early devoted himself to the study of technical chemistry under Fresenius at Wiesbaden. At the age of twenty-seven he was appointed to the department of the Pathological Institute by the late Prof. Virchow, who formed a high opinion of his abilities. In 1872 Dr. Liebreich became director of the Pharmacological Institute in Berlin. His name will always be associated with the introduction, in 1872, of hydrate of chloral as a therapeutic agent, which has since been used widely as an anodyne and narcotic. He was an authority on the treatment of lupus, and published a number of works and special articles on this and other questions of therapeutics.

THE seventh International Congress of Applied Chemistry is to be held in London from May 27 to June 2, 1909, under the hon. presidency of Sir Henry Roscoe, F.R.S., he himself being the acting president. It is hoped that the Prince of Wales will open the congress. The meetings will be held in the University Buildings, in the Imperial College of Science, and in the Central Technical College. The special sections and their presidents will be as follows:—analytical chemistry, Dr. T. E. Thorpe, C.B., F.R.S.; inorganic chemistry and allied industries, Dr. Ludwig Mond, F.R.S.; (*a*) metallurgy and mining, Sir Hugh Bell, Bart., (*b*) explosives, Sir Andrew Noble, Bart., K.C.B., F.R.S.; organic chemistry and allied industries: (*a*) organic products, Prof. W. H. Perkin, F.R.S., (*b*) colouring substances and their uses, Prof. Meldola, F.R.S.; industry and chemistry of sugar, Mr. Richard Garton; starch industry: (*a*) starch industry, Dr. Horace T. Brown, F.R.S., (*b*) fermentation, Mr. John Gretton, M.P.; agricultural chemistry, Lord Blyth; hygiene, medical and pharmaceutical chemistry—bromatology, respectively, Sir J. Crichton Brown, F.R.S., Mr. N. H. Martin, and Mr. R. R. Tatlock; photographic chemistry, Sir W. de W. Abney, K.C.B., F.R.S.; electrical and physical chemistry, Sir John Brunner, M.P.; and law, political economics, and legislation with reference to chemical industries, Lord Alverstone. The provisional programme has been drawn up; it comprises the opening meeting in the Albert Hall, a conversazione at the Natural History Museum, a banquet at the Crystal Palace, and lectures by Profs. Haller, Otto Witt, and Nasini, and by Sir Boverton Redwood. Committees have been formed in foreign countries to organise the work of the sections, and an executive committee has charge of the arrangements at home. It is anticipated that the congress will be largely attended; meetings in Paris, Berlin, and Rome were attended by about 3000 chemists. The honorary secretary is Mr. William Macnab, of 10 Cromwell Crescent, S.W.

Dr. Luiz Cruls, whose death we recorded in our issue of July 2, was born at Diest, in Belgium, in the year 1848. The early years of his manhood were devoted to the military service of his country as an officer in the Engineers. In 1881 he accepted the post of director of the observatory at Rio de Janeiro, and from that date he took a prominent part in scientific work in Brazil. In addition to the directorship of the observatory, he held the post of professor of geodesy and practical astronomy in the military academy. He was also the head of many scientific commissions appointed by the Brazilian Government, among others of that for the exploration of the central plateau of Brazil, and the report of this commission forms an important part of his scientific work. His remaining contributions tn scientific literature were of an astronomical or meteorological nature. One of the most important was a report on the observations of the transit of Venus, made at Punta Arenas in 1882. Numerous other astronomical papers appeared in the *Comptes rendus* of the Academy of Sciences of Paris. A detailed discussion of the climate of Rio de Janeiro calls for special mention among his meteorological works.

Among the list of new fungi determined by Mr. G. Massee, and recorded in the current number of the *Kew Bulletin*, there is a notable species from Grenada, *Nectria theobromae*, a parasitic fungus that forms "bleeding" wounds on the bark of cacao trees. From Old Calabar was received an edible agaric, *Volvaria esculenta*, that grows on coffee pulp. *Boletus curtipes* furnishes the first record for the genus from South Africa.

When visiting the German colonies in tropical Africa, Dr. W. Busse paid special attention to the effects of the grass fires periodically kindled by the natives, and has summarised his observations in the *Mittheilungen aus den deutschen Schutzgebieten* (vol. xxi., part ii.). The original motive would be to clear the land for cultivation, or by burning the old stems to induce a fresh growth of young shoots, and occasionally to drive the wild game for a battue. The general result has been to produce, as in Togoland, the "steppe" vegetation where originally forests existed. Although directly and indirectly the consequences are in the main disastrous, it is noted that by the destruction of dangerous insects fires may serve to check such evils as the "surrah" disease.

A substantial account of the Fucaceæ, prepared by Mr. K. Yendo and published in the Journal of the Royal College of Science, Tokio (vol. xxi., article 12), forms a welcome addition to algal literature. With regard to distribution, it is noted that species of Fucus and Pelvetia are confined to the north, Cystoseira to the Loochoo Islands, and a boundary between cold and warm sea forms can be set at Kinkwasan Island on the east and Ojika peninsula on the west. Sargassum is the largest genus, with forty-one out of fifty-nine recorded species, and six species are assigned to Cystophyllum. *Coccophora Langsdorfi* is an interesting species with a perennial knotty stump, from which arise two distinct kinds of branches; similar differentiation is noted for an alga that is made the type of a new genus, Ishige. A series of fine illustrations adds to the value of the critical notes on the various species.

An interesting contribution to the cytological structure of cœlenterates is made by Mr. H. B. Bigelow, who has studied the cell divisions in *Gonionemus murbachii*, and has published his results in the Bull. Mus. Comp. Zool. at Harvard College (vol. xlvii.). The nuclei possess in somatic cells about twenty-four chromosomes, and the nucleolus is regarded as consisting of a peripheral shell of chromatin enclosing a non-chromatic substance. During the reductions, suggestive stages were made out recalling the observations made by Korschelt on Ophryotrocha. The chromosomes arise by stages closely resembling those seen in a somatic mitosis. There is, however, an early synapsis-like ("pseudosynapsis") appearance which Bigelow interprets as an artefact. The modified spireme forms a reticulum, which then breaks up into about twenty-four spherical chromatin masses. This fact is remarkable, inasmuch as there are twenty-four somatic chromosomes, but in the preceding spermatogonial mitoses each of these arises by the coalescence of two "chromomeres." The author regards, on grounds which do not seem to us to be conclusive, the twenty-four chromatin spheres, not as the equivalents of somatic chromosomes, but as chromomeres, and hence concludes that a reduction has already occurred. But it seems at least as probable that we are really dealing with a belated pairing, to form the pseudochromosomes, and this would bring the process into line with some cases of the sort already known elsewhere. The details given of the maturation of the egg seem not to be opposed to such a view. The author is excessively cautious in drawing conclusions, and whilst this is a wise position to adopt for the present, it is to be hoped he will continue his observations so as to enable him to put forward his interpretation with more confidence.

In 1811 the Spanish Viceroy of Mexico addressed to the authorities in California a series of questions designed to procure information regarding the Indian population attached to the Missions, their manners and customs, religious beliefs, and social condition, and the results produced on them by missionary teaching. The original replies to this series of interrogatories, prepared by the authorities of the leading missions, now form part of the Bancroft Library at the University of California, and have been translated and published as the first Bulletin of the eighth volume of their Transactions, with excellent annotations by Mr. A. L. Kroeber. The replies are naturally of varying degrees of value. Some exhibit a good knowledge of the people among whom the authors worked; and they generally display a spirit of tolerance towards non-Christian beliefs, thus forming an interesting picture of native society before it had been much influenced by Europeans, and long before the period of scientific ethnology. In particular, the accounts of the vulture sacrifice as a mode of commemorating the dead, the feathers of the bird being used as a dress of a boy who danced before the community; and the use of jimson-weed (*Datura meteloides*) as a means of producing the ecstatic condition in youths at the initiation ceremony, when they saw visions, and were instructed in the religious beliefs and practices of the tribe, deserve special notice.

In an address delivered before the National Geographic Society of America, published in the May number of the

*National Geographic Magazine* under the title of "An American Fable," Mr. Gifford Pinchot, chief of the United States Forest Service, raises the question of the exhaustion of the national resources, a subject which has recently been discussed by President Roosevelt. The growth of the forests at present is, he states, but one-third of the annual consumption, and the timber will last only twenty years at the existing rate of expenditure. For a country so largely dependent on wood for building and fuel, the result of the wasteful policy of the last half-century will be disastrous, and Canada, the only available source of supply, will soon need all her timber for her own use. The anthracite coalfields, again, are said to be in danger of exhaustion in fifty years, and the bituminous coal will fail early in next century. Some of the older oilfields are already worked out; the natural gas has been wasted, burning night and day in many townships. Iron deposits grow less every year. The ranches in the west feed only half the cattle which they would produce under intelligent management, and the prices of meat are rapidly rising. The present, he observes, is one of the most critical epochs in the national history, and disaster is sure to occur unless a policy of conserving these resources is enforced. The only practical remedy, he suggests, for this dangerous state of things is the appropriation of the vast supplies of water power for the production of electrical energy to take the place of coal for machinery, heating, and illumination. If these fall into the hands of trusts the prospect is gloomy in the extreme. "We are no more exempt from the operation of natural laws than are the people of any other part of the world."

The new Bernese Alpine Tunnel and the Lötschberg Railway are discussed in an article by Dr. C. Koppe in *Himmel und Erde* for April. In pointing out the hindrance caused by the Bernese Alps to the utilisation of the Simplon Tunnel route, Dr. Koppe emphasises the great commercial advantages, not only to Bern and north-west Switzerland, but also to the western Rhine district, which would follow the construction of a railway connecting Brieg, at the northern end of the Simplon Tunnel, with Bern. The first part of the line, from Spiez to Frutigen, has been constructed for several years, and it has been decided to continue this line to Brieg, a tunnel being pierced through the Bernese Alps at Lötschberg. The building of the lines from Brieg and Frutigen to the south and north of the tunnel entrance will be commenced in the summer of 1908, and the whole international railway, Bern, Lötschberg, Simplon, should be completed in five years. The Bernese Alpine Railway Company was formed in July, 1906, and the work of triangulation carried out in the autumn of the same year, accurate data being obtained for fixing the length and direction of the tunnel. The three mountains situated on the line of the tunnel, First, Immenengrat, and Wildelsiggrat, were used as bases for the survey. Boring was commenced in the spring of 1907, electric power being derived from works at Spiez and Gampel. Dr. Koppe gives a detailed description of the proposed line from Frutigen, through Mitholz and Kandersteg, to the tunnel entrance, and also of the line from Goppenstein to Brieg, noticing the numerous small tunnels and viaducts which will be required.

We learn from the *Bulawayo Chronicle* that at a meeting of the Rhodesian Scientific Association on May 19, the Rev. Father E. Goetz, S.J., read a useful paper on the rainfall of Southern Rhodesia, based on observations at about fifty stations, reduced to the period 1888–1907. Among the principal results we note that Mashonaland, as a whole, has an annual average of more than 30 inches; the eastern range of high altitudes has 40 inches and upwards, while on the slopes towards the Zambesi and Limpopo the average is between 25 and 30 inches. Matabeleland is much less favoured; along the watershed the average is 25 east of Bulawayo and 20–25 west of that place. Between April and October not more than an inch of rain falls on an average in Rhodesia, west of the eastern range of high altitudes; from October to March 90 to 98 per cent. of the year's rainfall takes place. Reference must be made to the original paper for many very interesting details in connection with the *régime* of the rainfall and the influence of wind direction. With regard to the question of cycles the author states that, although there are only ten years' barometer observations available, his inquiries show that investigation on the line of a 19-year variation in the barometer and of a corresponding variation in the rainfall might perhaps be continued with profit.

Prof. Silvanus P. Thompson's "Kelvin Lecture," delivered to the Institution of Electrical Engineers on April 30, has been issued as a separate pamphlet by Messrs. Spon. It consists of a sketch of the life and work of Lord Kelvin, and gives within its short compass a more vivid picture of the great master than have several more lengthy accounts.

The Sanitas Electrical Co., Ltd., of New Cavendish Street, London, W., has sent us a profusely illustrated and conveniently arranged catalogue, running to 338 pages, dealing with electromedical apparatus which the company is prepared to supply. The catalogue provides remarkable evidence of the numerous applications in medical and surgical science of the Röntgen and other rays. Incidentally, the appliances described in the catalogue serve to illustrate the debt of gratitude which mankind owes to the men of science upon whose work, often little recognised, these remedial measures are based.

M. P. Villard exhibited before the Société Française de Physique on May 4 an experiment in which the Aurora Borealis was produced artificially (see Nature, September 5, 1907, vol. lxxvi., p. 481), and a complete description of the method used is given by M. Villard in the June number of the *Journal de Physique*. A large exhausted flask is placed between the poles of an electromagnet, and a stream of kathode rays is shot into the flask in a direction oblique to the magnetic field. In these circumstances the rays become a luminous spiral with its axis directed towards one of the poles of the magnet. At a point near this pole the path of the ray is nearly reversed, and the spiral proceeds towards the other pole, at which the reversal is repeated. Owing to the axes of the spirals being slightly inclined to the lines of the field, they generate a spheroidal surface coaxial with the field with a circular piece cut out at each pole. According to the theory which this experiment at once suggests, in our observation of the aurora we are looking at the edge of one of these openings from underneath, the spirals coming nearest to the earth's surface at these points and being most luminous.

Messrs. Leitz, of Wetzlar and London, have submitted for our inspection one of their prism binoculars of improved design. Like the majority of modern instruments of this type, these are constructed on the principle of Porro's erecting prisms, but several additional patents on details enable special points of excellence to be claimed. The tubes are provided with focussing arrangements and inter-pupillary adjustment. For the former, the focussing is done separately for each eye by rotation of the eye-pieces, controlled by a scale for future setting. Although at first this may appear more inconvenient than the usual double screw motion of both tubes, this is not found to be the case during continued usage, and the makers are enabled to introduce the very desirable feature of making the prism cases quite dust and moisture proof, which is almost impossible when sliding tubes are employed. As issued, the magnifying power is 6, and the field of view about 7°. With respect to the varying opinions as to the best arrangement of the object-glasses for stereoscopic effect, Messrs. Leitz have decided that the advantages of placing them further apart than the pupillary distance are questionable, and so the object-glasses are fitted at the same interval as the eye-pieces. The binocular is made of a specially strong light metal, the weight being only 12 oz. without case. We can without hesitation speak very highly of the optical performance of this instrument. The definition is remarkably crisp, and the image very achromatic and quite sharp up to the edge of the field of view.

A general index to the annual volumes, sixteen in number, published by the Geological Survey of Canada since 1884, has been compiled by Mr. Frank Nicolas and issued at Ottawa by the Geological Survey. The index runs to 1014 pages, and contains about 180,000 references. It should prove of great service to investigators anxious to refer expeditiously to the annual volumes of the Canadian Survey. The present catalogue, combined with the index previously published, and dealing with the publications from 1863 to 1884, forms a complete means of reference to the English edition of the volumes issued by the Geological Survey of Canada.

## OUR ASTRONOMICAL COLUMN.

Radial Velocities of Ninety-nine Stars.—The largest single contribution to line-of-sight work yet made appears in No. 5, vol. xxvii., of the *Astrophysical Journal* (pp. 301–24, June). The results were obtained by Prof. Küstner and Dr. Zurhellen, at the Bonn Observatory, during the years 1903–7, and include the provisionally determined velocities of ninety-nine stars of the second and third spectral types down to the fourth visual, or fifth photographic, magnitude.

A three-60°-prism spectrograph by Töpfer, giving a well-defined spectrum between $\lambda\lambda$ 4150 and 4500, was employed, the temperature being automatically controlled by electric means; at H$\gamma$ the linear dispersion is such as to give 15·2 tenth-metres per millimetre.

Although the present values for the radial velocities are only provisional, it is expected that they will not be greatly modified in the final definitive results. In addition to fifteen previously known variable velocities, the ninety-nine sets of results include those for three other stars, $\delta$ Tauri, $\epsilon$ Böotis, and $\mu$ Pegasi, the radial velocities of which are suspected to be variable. The comparison spectrum employed in each case was that of the iron arc, Kayser's values of the wave-lengths being taken; Rowland's values were taken for the stellar lines. As the observations included some 7500 complete measures of about forty-four different stellar lines, Prof. Küstner expects that their discussion will provide good exact values for the relative wave-lengths of the latter, and also indicate their dependence on the type. In discussing the determination of the constant correction, due, first to the absolute errors of the wave-lengths adopted, and, secondly, to the personal and instrumental errors, Prof. Küstner considers as invalid the control usually obtained from plates exposed on the sun, moon, or larger planets. He believes that a source of light, of precisely known radial velocity and *as similar as possible to the star*, should be observed, and suggests the employment of the brightest minor planets or of Jupiter's satellites for this purpose. After many experiments, and at Dr. Zurhellen's suggestion, he employed spectrograms of the bright isolated peaks seen at the moon's terminator, and found the results to be satisfactory. These indicate that a small negative correction of about −1·0 km. should be applied to the results now published. Of the constant radial velocities determined, that of $\eta$ Cephei, −85·98 km., is the largest.

The Observation of Coloured Stars.—In No. 4252 of the *Astronomische Nachrichten* (p. 57), Herr Osthoff discusses at some length the changes of the colour perception of the eye, and shows that these changes depend upon the physiological condition of the observer as well as upon the intensity of the colour of the observed object and upon the instrument used. A table containing the results of his own observations between January, 1894, and November, 1898, shows the variation of the difference between his estimates of colour and the catalogue colour of the stars observed; other tables show the variation of the eye's colour-perception for red and yellow stars respectively, and it appears that the eye is more uncertain in estimating the red than the yellow. The importance of this fact in observing the magnitudes of coloured variable stars is pointed out. There is some indication of a periodical change in the individual eye, but the observations are not sufficiently numerous to establish this.

Photometric Observations of Eros.—During the period September, 1907, to January, 1908, Dr. Paul Guthnick made a number of photometric observations of Eros at the Berlin Observatory, and now publishes and discusses the results in No. 4249 of the *Astronomische Nachrichten* (p. 1, vol. clxxviii.). From his discussion he is unable to establish with certainty the existence of any short-period light-variation. On plotting the light-curve, taking into account the phase-variations, and trying periods of 5·24h., 5·28h., and 5·32h., he obtained a negative result. It appears certain that during the greater part of the opposition any short-period variation was imperceptible.

The Photography of Very Faint Spectra.—The expedient of slightly fogging plates on which it is proposed to photograph faint objects is generally known, but is apparently not so generally adopted. Having recently employed this procedure very successfully in the photography of faint spectra, Mr. R. W. Wood, of the Johns Hopkins University, describes his method and results in No. 5, vol. xxvii., of the *Astrophysical Journal* (p. 379, June). The curve representing the action of light on a sensitised plate is at its commencement flat, but after reaching a certain point it begins to rise much more rapidly; Mr. Wood's supplementary exposure carries the darkening of the plate to this point, so that the radiations he is wishing to photograph commence their action at that part of the curve where a given exposure is much more effective in producing density than if it were applied alone. By a judicious use of the method he has succeeded in reducing the exposure, necessary to produce a certain density, by one-half. The preliminary exposure needed is very small; with a gas flame turned down until the yellow tip was but 3 mm. or 4 mm. high, four seconds at a distance of about two metres was found to be sufficient.

## JULY AND AUGUST METEORS.

THE meteoric season of July has again returned, bringing with it all the interesting associations attached to this period in previous years. Early Perseids will now be occasionally seen with their rapid flights, and leaving streaks upon their paths, but they will be directed from the southern region of Cassiopeia instead of from the place 45°+57°, as at the maximum epoch on August 11–12. Many long-pathed and slow-moving Aquarids will also be noticed from the point about 339°−10°, and this display generally develops its richest features near the end of July, on about the 28th to 30th.

A few years ago I sifted all my observations at the July and August periods with a view to find the most active radiants determined at Bristol, and the number of meteors recorded from them. Omitting Perseids, the following is a list of the principal systems:—

| Radiant R.A. ° | Dec. ° | Periods July 20–Aug. 16 meteors | Aug. 19–25 meteors |
|---|---|---|---|
| 7 | +11 | 31 | 26 |
| 9 | +39 | 44 | 5 |
| 24 | +42 | 35 | 23 |
| 30 | +36 | 43 | 12 |
| 47 | +43 | 59 | 25 |
| 61 | +48 | 21 | 26 |
| 271 | +48 | 32 | 9 |
| 291 | +60 | 44 | 69 |
| 292 | +52 | 72 | 9 |
| 304 | −12 | 31 | — |
| 312 | +12 | 30 | 9 |
| 315 | +48 | 38 | 10 |
| 315 | +78 | 24 | 6 |
| 333 | +48 | 53 | 6 |
| 333 | +28 | 37 | 8 |
| 333 | +71 | 50 | 31 |
| 339 | −10 | 237 | 20 |
| 348 | +50 | 52 | 17 |
| 345 | +1 | 28 | 29 |

The complete table of showers, rich and feeble, appeared in *Astronomische Nachrichten*, No. 3874. About eighty-five systems in all were displayed between July 16 and August 20.

It would be interesting if some of these streams could be re-observed during the oncoming return of the Perseids and their radiant points re-determined. The positions given in the table may be relied on as accurate to within 2° of probable error, but some of the radiants are more exact than others, the centres having been more sharply defined. In the case of showers of swift, streaking meteors, the intersecting points of the flights can generally be ascertained with great precision.

Special attention seems necessary to be given to the period about July 11–12, when the first signs of the Perseids decidedly begin to be manifested.

This year moonlight will seriously interfere with observations for about a week near July 13 and August 12. The maximum display of Perseids will be partially overpowered by the radiance of our satellite, but some brilliant meteors will be observed at about the epoch August 9–13 should the skies be clear. W. F. DENNING.

## MAGNETIC RESOLUTION OF SPECTRAL LINES.

PROF. P. ZEEMAN, continuing his investigations on the occurrence of asymmetric separation of spectral lines in a magnetic field (see NATURE, April 30, vol. lxxvii., p. 615), describes a series of observations on asymmetrical triplets (*Konink. Akad. Wetens. Amsterdam*, p. 566, March 27). As a method giving independent confirmation of the previous work was desirable, he decided to investigate the new series by means of the Fabry and Perot interferometer, using the *étalon*—that special form of the instrument in which the distance between the silvered surfaces is kept constant, about 5 mm. The variations of wave-length may in this case be determined either by continued measurements of the same interference ring or by the method of coincidences, regulating the magnetic force in such a manner that a ring which expands by increasing magnetic intensity coincides with a contracting ring. The system of rings was formed in the focal plane of a small achromatic lens of 18 mm. aperture and 12 cm. focus. This focal plane coincided exactly with the plane of the slit of a one-prism spectroscope, the width of the slit being so reduced that the rings produced by the two yellow mercury lines at λλ 5791 and 5770 could be observed separately.

Reproductions of the appearances presented with magnetic field off and on are included with the paper, made from enlarged negatives. The measurements given indicate conclusively that the positive results concerning asymmetric resolution in strong fields have a real significance, and a very interesting discussion of the results is appended. Taking Lorentz's equation for determining $e/m$, and accepting J. J. Thomson's value of $e=1\cdot1\times10^{-20}$ electromagnetic units, the number of electrons per unit volume causing the radiation of the yellow mercury line 5791 in a vacuum tube appears to vary from $8\times10^{16}$ to $4\times10^{16}$ with magnetic fields varying from 29,220 to 9130 Gaussian units. In these experiments the temperature of the vacuum tube was between 100° C. and 120° C.; the corresponding vapour pressures of mercury, according to Hertz, would be 0·29 mm. and 0·78 mm. respectively, and it is calculated that the number of electrons participating in the emission of line λ 5791 is of the same order of magnitude as the number of atoms present.

A number of observations made by Mr. Jack in the physical laboratory at Göttingen are also recorded, showing the asymmetrical separations of lines of wolframium and molybdenum. The paper concludes with a question as to the possibility of the wave-length of the central line of a triplet being changed by the action of the magnetic field as compared with the unmodified line, and some observations made with an echelon appear to indicate that some lines undergo in strong fields displacements of the order of six or ten thousandths of an Angström unit, in most cases towards the red. This is to be further treated in a subsequent paper.

## SOCIAL ANTHROPOLOGY.

PROF. J. G. FRAZER has made a good start in the work of his chair at the University of Liverpool by his opening address on "The Scope of Social Anthropology." It is characterised by all the lucidity of exposition and grace of style which we are accustomed to expect from the author of "The Golden Bough." His main object is to plead for the systematic study of savages, who represent an arrested, or rather retarded, stage of social development. They are, he is careful to point out, primitive only in a relative, not in an absolute, sense: that is, they are primitive in comparison with ourselves, not in comparison with primæval man, of whom we know nothing, and, so far as we can see at present, are likely to learn nothing.

The province of social anthropology falls into two departments, one embracing the customs and beliefs of savages, the other including such relics of these as have survived in the thought and institutions of more cultured peoples. The first department may be called the study of savagery, the second the study of folk-lore. The government of mankind, he goes on to show, is always and everywhere essentially aristocratic, that is to say, the dull-witted majority always follows the keener-witted minority. In the mental, no less than in the physical sphere, the struggle is internecine; but in the end the better ideas, which we call the truth, carry the day. Hence, even in a civilisation like our own, we find the lower classes still following magical and other primitive practices of the same kind. Not that schemes for the regeneration of society form part of his programme. The study of the past must throw light upon the problems of the present, but the exploration of schemes of social reform is the business of the sociologist, not of the social anthropologist.

Dr. Frazer closes a remarkable address by an impassioned appeal for the more careful study of that savagery which is so rapidly disappearing. "How shall we of this generation look when we stand at the bar arraigned on a charge of high treason to our race, we who neglected to study our perishing fellow-men, but who sent out costly expeditions to observe the stars and to explore the barren ice-bound regions of the poles, as if the polar ice would melt and the stars would cease to shine when we are gone?"

## RECENT RESEARCHES IN THE STRUCTURE OF THE UNIVERSE.[1]

### II.

*Localisation of the Stars in Space by a Sorting Process.*

THE method may be best explained as a *sorting* process. The process was not actually followed; it would have been too laborious, and would have met with some difficulty.[2] But the difference is immaterial, and the present description has, I think, the advantage in point of clearness. Let each of the stars of the second, third, &c., to the eighth magnitudes be represented by a little card on which are inscribed the apparent magnitude and the apparent proper motion of the star. Then imagine three sets of boxes.


Fig. 1.

*Classification according to Magnitude.*

1st Set.—*Apparent magnitude boxes* represented in Fig. 1.—In the box for the second apparent magnitude, as many cards are put as there are stars of the second magnitude in the sky. The total numbers of stars for each magnitude are inscribed on the lid. We thus see that there are in the whole of the sky forty-six stars of the second magnitude, 134 of the third, and so on.

*According to Magnitude and Proper Motion.*

2nd Set.—*Magnitude-motion boxes* (Fig. 3). The stars in each of the former series of boxes are re-distributed over a series of boxes, each of them containing stars of a determined apparent motion. By way of an example, Fig. 3 shows this new classification for the stars of the *fifth* apparent magnitude. There is, of course, another such series for each one of the apparent magnitudes. Those for the *fifth* have been distributed over twenty-eight new boxes. In the first have been collected the cards representing the stars with a proper motion of 0″ to 1″ per century. The average motion is 0·5, and this has been inscribed on the lid. The little arrow indicates that this number represents a motion. The number 5 surrounded by a star refers to the fact that we have exclusively to do with stars of the fifth apparent magnitude. The second box contains the stars with proper motion between 1″ and 2″ per century, &c. For the larger motions the limits have been taken somewhat wider. In the eleventh box the motions 10″ to 15″ are contained, in the thirteenth those between 20″ and 30″, and so on. The number of star-cards in each box has been inscribed on the lower right-hand corner of the lid. The figure thus shows, for instance, that there are in the sky ninety stars of the fifth magnitude having a proper motion between 0″ and 1″ per century. We have thus arranged the stars according to both the rough criteria of distance at our disposal; for we know perfectly well that in a very general way the fainter the stars and the smaller their apparent motion the further they must be away.

For each of the groups thus obtained we are now able, according to what has been said before, to derive the *mean* distance. This determination being made, we obtain the mean distances expressed in light-years which have been inscribed on the lid with the letter MD prefixed. Already we may see now how incorrect it is to imagine all the stars of the fifth magnitude to be placed at one and the same distance, as Struve did. According to the numbers in our figure, the distance varies from 1670 light-years for the stars of the first box to eleven light-years for those of the last. It is true that just the data for these extreme boxes are the most uncertain; still, it is evident that even in these mean distances there must be an enormous range.

But to proceed. The eighty-six stars in our sixth box (see Fig. 3) are at an average distance of 248 light-years.

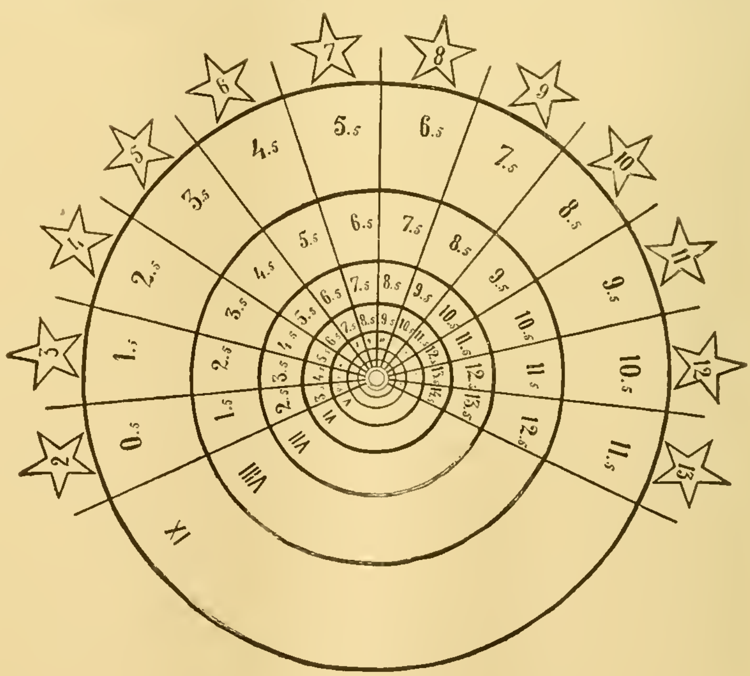



FIG. 2.

Are we compelled to stop here and to *assume* that the real distance of *all* the individual eighty-six stars is 248 light-years? If it were so we would *surely* still have gained a considerable advantage over Struve. For, owing to want of other data, he saw himself compelled to treat all the stars of the fifth magnitude, that is, the whole of the twenty-eight groups in our boxes, as if they were all at the mean distance of the whole. But yet there would remain in our solution a defect *of the same kind*, and it

[1] Discourse delivered at the Royal Institution on Friday, May 22, by Prof. J. C. Kapteyn. Continued from p. 212.

[2] For many of the stars used the proper motion is still not known. What is known, however, is the percentage of the stars of each magnitude having a determined proper motion. This knowledge enables us to put in every box the required *number* of cards showing a determined proper motion, and this is all that is wanted in what follows.

would be impossible to say in how far the results definitively to be obtained would be influenced. Happily there is an escape.

For our last classification, the classification in the distance-boxes, it is of no particular advantage that every individual star gets in its proper distance-box. It will be sufficient to know how many stars will finally be found in each distance-box. If this result is obtained, we shall presently see how easy it becomes to study the problem put at the beginning of this lecture. Our aim will be evidently reached if we can find out *how many per cent.* of the stars in any one box have such and such a distance. Now, in order to determine these percentages, it will be sufficient to investigate *a sample* of our stars.

*Stars of Measured Distance taken as a Sample.*

Happily there is the possibility of taking a sample that will help us out of the difficulty, for, as we know, there are in the sky a hundred stars of which astronomers have succeeded in determining the individual distance with some accuracy. We take these as our sample. They are distributed over a great many of our boxes.

We take them all out, having a care to note for all of them the mean distance of the stars in the box to which they belong. For all the hundred stars we now compare their mean distances to their true distances, and thus find out how many per cent. of them have true distances between *two* and *three*, *four* and *five tenths*, and so on, of the mean distance.

*3rd Set.—Distance boxes.* These percentages are all we want for our last distribution, the distribution over the distances. It is true that our sample is a somewhat undesirably small fraction of the whole; it shows besides some other weak points, but it appears happily *a posteriori* that even rather considerable uncertainties in these percentages have but an unimportant influence on the results. We are thus at last enabled to distribute our star-cards according to the true distances. I made the distribution over the spherical shells shown in Fig. 2.

The dimensions of these shells have been so chosen that if a star is removed from one shell to the next further one, the observer at the centre will see the star grow fainter by just one magnitude, that is, it will grow very nearly $2\frac{1}{2}$ times fainter.

The figure is not well fitted for bringing out the details of our results. The shells become too narrow towards the centre, and the more central ones do not allow of the insertion of sufficiently clear figures. For this reason I constructed Fig. 4. The numbers valid for the several spherical shells have here been entered in equally broad horizontal rows. The drawing does not therefore show the real dimensions, but these as expressed in light-years, which may be read off on the right-hand side of the drawing. We thus see that the central sphere extends to a distance of twenty-one light-years, that the second spherical shell extends from twenty-one to thirty-three years, and so on. In these rows a last set of boxes is placed. There is a box for each apparent magnitude in each of the rows. The stars of the boxes of Fig. 3 are thus, of course, all contained in the vertical row of boxes, corresponding to apparent magnitude five in Fig. 4.

*Distribution according to Distance Illustrated by Example.*

In order to illustrate by an example how the stars of the boxes in our Fig. 3 are distributed over our different shells, that is, over our *distance boxes* of Fig. 4, take the seventh box. It contains seventy-seven stars at a mean distance of 220 light-years. Our countings on the sample showed that about *one-fifth* of the stars have *true* distances which are between 37 per cent. and 59 per cent. of their *mean distance* (derived from their apparent magnitude and proper motion). Therefore about one-fifth of our seventy-seven stars must have true distances between 37 per cent. and 59 per cent. of 220 light-years, that is, between eighty-two and 130 light-years—or, finally, fifteen stars of our box must find their place in the fifth shell of Fig. 4, that is, in the box corresponding to the fifth apparent magnitude in that shell. In precisely the same way I find that twenty-one of them must be placed in the sixth shell, eighteen in the seventh, ten in the eighth, and so on.

If, after that, we repeat the process for all the remaining boxes of Fig. 3, we get, for the fifth apparent magnitude, the numbers inscribed on the lower side of the boxes corresponding to that magnitude in Fig. 4.

Further than for the eleventh shell no numbers have been entered. They become too uncertain. As, however, we know the *total* number of stars of each apparent magnitude, we know the aggregate number which remains to be distributed over the whole of the further shells.

What has here been explained for the stars of the fifth magnitude has been also done for the other magnitudes between the second and the eighth. The whole of the results are shown in our Fig. 4.

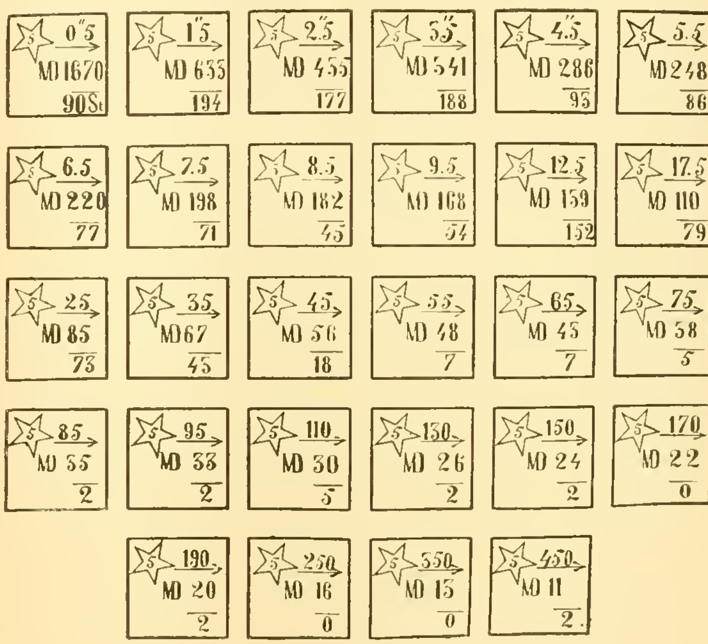


Fig. 3.

*Stars of Equal Luminosity brought together.*

The main result of the investigation is embodied in these numbers—and *first*, in every box stars have now been brought together of equal absolute magnitude—that is, of equal luminosity. For as the stars in each box are at the same distance, and as, at the same time, they are of equal *apparent* brightness, they must, of necessity, be of equal total light-power, that is, according to our definition, of equal luminosity or absolute magnitude. For the absolute magnitude of a star I have taken the magnitude the star would show if placed at a distance of 326 light-years. The choice of just this number is simply a matter of convenience, and need not be explained here.

As a consequence, the stars at a distance of 326 years, which to us appear as stars of the fifth magnitude, will have also the absolute magnitude five. Those of the same apparent magnitude, but at a distance of 517 light-years—that is, just one shell further—must have the absolute magnitude four in order to show us the same brightness, notwithstanding the greater distance. Now our eighth shell lies just between these limits of distance. In the middle of this shell, therefore, the stars of apparent magnitude five must have absolute magnitude 4·5. In the box, therefore, belonging to the fifth apparent magnitude, eighth shell, all the stars are of absolute magnitude 4·5. In the ninth shell a star must already have the absolute magnitude 3·5 in order to shine as a fifth apparent magnitude at this greater distance, and so on. In this way the absolute magnitudes were found which in our figure have been inscribed on the lids of the boxes.

We are now able to derive at once the *mixture law*, *i.e.* the proportions in which stars of different absolute magnitude are mixed in the universe. For in one and the same shell (eleventh) we find two stars of absolute magnitude −1·5, as against three of magnitude −0·5, fifteen of absolute magnitude 0·5, seventy-six of absolute magnitude 1·5, &c.

That is, our results for the eleventh shell furnish us with the proportion in which stars of absolute magnitude −1·5, −0·5, &c., to 4·5, are mixed in space. The tenth shell gives the proportions for all the absolute magnitudes between −0·5 and 5·5, and so for the rest. All the shells together give the proportions for the absolute magnitudes

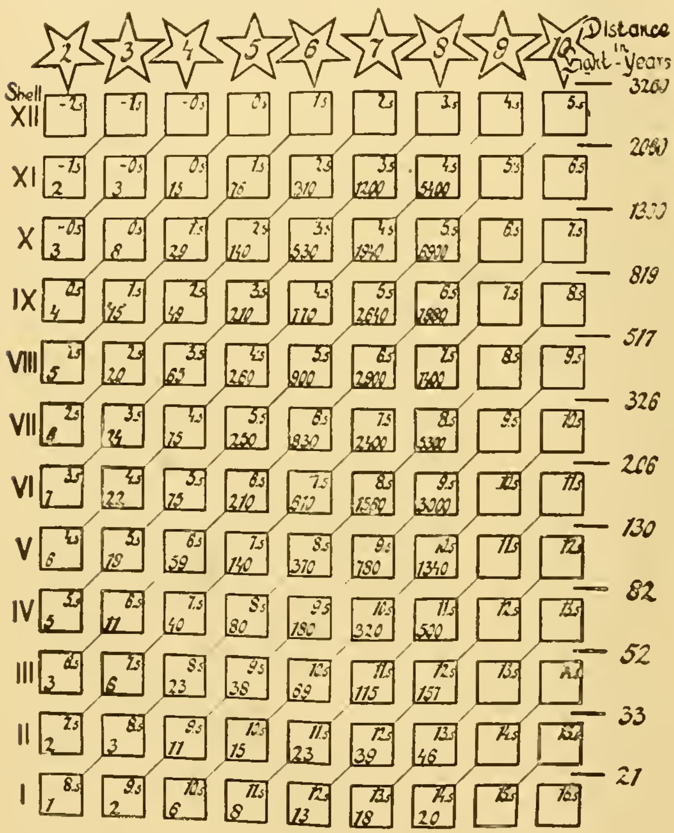



Fig. 4.

−1·5 to 14·5, that is, for a range of not less than sixteen magnitudes. Not only that, but most of the proportions are determined independently by the data of quite a number of shells. So, for instance, the proportion of the stars of absolute magnitude 4·5 to those of absolute magnitude 5·5. Each of the six shells from the fifth to the tenth furnishes a determination of this proportion. All of them are not equally trustworthy. If we take this into account, we find that the agreement of the several determinations is fairly satisfactory. By a careful combination of all the results, a table representing the law of the mixture of the stars of different absolute magnitude was finally obtained. Rather than show you the direct result, however, I will first replace the absolute magnitudes by luminosities expressed in the total light of our sun as a unit. This will have the advantage of presenting a more vivid image of the real meaning of our numbers.

By photometric measures it was found that the sun, placed at a distance of 320 light-years, would shine as a star of magnitude 10·5. In other words, the sun's absolute magnitude is 10·5. A star of absolute magnitude 9·5 will, therefore, have 2·5 times the light-power—that is, 2·5 times the *luminosity* of the sun. A star of absolute magnitude 8·5 will again have a luminosity which is 2·5 times greater, and so on.

Such results evidently enable us to transform our absolute magnitudes into luminosities. Thus translated, I found the results shown in the following table.

*Luminosity Table.*

Within a sphere having a radius of 555 light-years, there must exist:—

| | | | | |
|---|---|---|---|---|
| 1 star | 10,000 | to | 100,000 | times more luminous than the sun |
| 46 stars | 1,000 | ,, | 10,000 | ,, ,, ,, ,, |
| 1,300 ,, | 100 | ,, | 1,000 | ,, ,, ,, ,, |
| 22,000 ,, | 10 | ,, | 100 | ,, ,, ,, ,, |
| 140,000 ,, | 1 | ,, | 10 | ,, ,, ,, ,, |
| 430,000 ,, | 0·1 | ,, | 1 | ,, ,, ,, ,, |
| 650,000 ,, | 0·01 | ,, | 0·1 | ,, ,, ,, ,, |

This table represents what, up to the present time, we know about the mixture law.

The fainter the stars, the more numerous.

The rate at which the numbers increase with the faintness is particularly noticeable for the very bright stars.

Passing to the fainter stars, this rate gradually diminishes, and it looks as if we must expect no further increase in number for stars the luminosity of which falls below one-hundredth of that of the sun. Meanwhile, this is simply a surmise. For stars of this order of faintness data begin to fail. Here, as in nearly every investigation about the structure of the stellar system, the want of data for stars below the ninth apparent magnitude makes itself very painfully felt.

But let us come back to our Fig. 4. I will *first* remark that, knowing the mixture law, we can predict the number of stars that we shall get in the empty boxes belonging to the ninth, tenth, &c., magnitude, as soon as continued astronomical observations will permit us to include these stars in our discussion. For the mixture law, as derived just now, shows that in our universe the stars of absolute magnitude 5·5 are 3·5 times as numerous as the stars of absolute magnitude 4·5.

Now as in the eleventh shell the number of stars of the absolute magnitude 4·5 is 5400 (see Fig. 4), there must be 3·5 times 5400, that is, 18,900 stars of absolute magnitude 5·5 in this shell. These belong all in the box of the ninth apparent magnitude of this shell. In the same way we obtain the number of stars to be expected in the boxes of the tenth, eleventh, &c., apparent magnitude for all our shells down to the eleventh. There is exception only for the boxes belonging to the lower shells, for which the absolute magnitude would exceed 14·5.

It is evident, however, that the number of stars in these exceptional boxes must be small, and for what follows they are of little importance.

*Star-density.*

*In the second place*, our boxes now also lead to the determination of the *star-densities*. For the volumes of the consecutive shells are perfectly known; they are in the proportion of 1 : 3·98. For the sake of convenience, let us say that the volume of each shell is exactly four times that of the next preceding one. Now, to take an example of the determination of the densities, consider the ninth and tenth shells (see Fig. 4). In the ninth there are forty-nine stars of absolute magnitude 2·5. Therefore, if in the tenth the stars were as thickly crowded as in the ninth, there would occur in this shell four times forty-nine, that is 196 stars of this absolute magnitude 2·5.

In reality we find but 140 of these stars. The conclusion evidently must be that the star-density in the tenth shell is about 140/196, that is, about two-thirds of that in the ninth shell. A similar conclusion is obtained by comparing the number of the stars of absolute magnitude 3·5 in the two shells. The values obtained from the magnitudes 0·5 and 1·5 may be neglected. Owing to the exceedingly small number of stars, they must necessarily lead to untrustworthy results. From all the rest I found that the density in the tenth shell must be about 64 per cent. of that in the ninth shell. The proportion between the densities in the other shells was determined in exactly the same way.

A slight defect in our results was then discovered. We should exceed the limits of the time allowed for this lecture by entering into a consideration of this defect. It must be sufficient to state that it was not difficult to remove it. After that it appeared that the density in the first six of our shells is nearly the same. The density in these shells, that is, in the neighbourhood of our sun, is such that about 2000 stars of a luminosity exceeding one-hundredth that of the sun must be contained in *a cubic light-century*. After the sixth shell the density diminishes gradually at such a rate that in the eleventh shell the density has fallen to about 30 per cent. of what it is in the vicinity of the solar system.

In what precedes we tried to give a solution of the problem put at the beginning of this lecture—a solution, however, which embraces only that part of the universe which is contained within a distance of about 2000 light-years from our solar system. Is there no possibility of getting beyond this distance?

I think there is, but, of course, you will not be astonished to find that the certainty of our conclusion diminishes as we get deeper and deeper into the abysses of space.

One of the reasons why the method thus far applied breaks down beyond the eleventh shell is that our data about proper motion are not refined enough to determine this motion with sufficient accuracy as soon as it is below 1″ in a century. Even the somewhat greater motions are rather uncertain. The proper motions thus cannot help us much beyond a certain distance. But we have still one valuable element for the solution of our problem. This element is the total number of stars separately for the apparent magnitudes. Thanks mainly to the photometrical researches at the Harvard Observatory, it has become possible to determine with considerable accuracy the total number of stars of the first, second, &c., to the eleventh magnitude; with a fair degree of accuracy even those for the magnitudes down to the fourteenth (inclusive).

The density in the shells beyond the eleventh, not only for the stars down to the eighth apparent magnitude, but, according to what has been said a moment ago, also for the apparent magnitudes of nine, ten, &c., to fourteen, has to be determined in such a way that the addition of all the numbers in any one vertical column of Fig. 4 produces just these totals for the corresponding apparent magnitudes.

It can be proved that after the eleventh shell the density must, on the whole, continue to diminish. If we assume that this diminution is gradual and proportional to the increase in distance, it becomes very easy to determine the rate of this diminution, and consequently the distance at which the density becomes *zero*, that is, the distance at which we reach the limit of the stellar system. We cannot enter into fuller particulars here. It must be sufficient to say that in this way we are led to conclude that the further diminution of density must be slow, so slow that in the assumption made above the limit of the system is only reached at a distance of some 30,000 light-years.

### *Hypotheses Underlying the Results.*

In conclusion, a few words on the question, In how far are the results now obtained to be considered as established?

The answer must be, They can be considered to be established only in so far, and no further, than we can trust the truth of the hypotheses which still underlie our reasoning.

For future consideration there thus remains the question, In how far can we test the validity of these hypotheses?

These hypotheses are the following:—

(1) The mixture was assumed to be the same at greater and smaller distances from the solar system.

(2) The same was done for different distances from the galaxy.

(3) The universe was assumed to be transparent, that is, it was assumed that the absorption of light in space is *zero*.

Can we get rid of these hypothetical elements?

I think we can, at least to a very great extent.

As to the *first*. Our Fig. 4 already goes far in enabling us to judge whether it is true or not. For evidently both our sixth and our ninth shell give the nature of the mixture, at least of the stars of absolute magnitude 3·5 to 6·5. Therefore, so far as these stars are concerned, we are able to see whether or not the mixture is the same at the distance of 650 light-years as it is at the distance of 170 light-years. Likewise, the figure enables us to make the comparison in other cases. As soon as we possess the necessary data for a longer range of apparent magnitudes, say down to the fourteenth or fifteenth, we shall be able to dispense to a very large extent with our first hypothesis.

As to the second, the possible variation of the mixture with the distance from the Milky Way, it is largely only the question of treating the stars in different galactic latitudes separately. So far as I can see, there are no particular difficulties in the way of such a separate treatment, at least not since the nature of certain anomalies in the distribution of stellar motions has been elucidated.

### *Absorption of Light in Space.*

Last, not least. Is the universe really absolutely transparent? There are reasons which make this seem very doubtful. A couple of years ago I obtained some evidence in the matter which shows that the absorption of light in space, if it exists to an appreciable amount, must at least be so small that over a distance of a hundred light-years not more than a few per cent. of the light can be lost. To determine so small an amount to within a small fraction of its total value will be a difficult task indeed. Still, we can even now see definite ways, which, given the necessary data for very faint stars and nebulæ, will probably enable us to overcome this last difficulty.

This want of data for very faint stars, which, in the present investigation, makes itself felt at every step, has led a number of astronomers to concerted action.

The express purpose of their cooperation is to collect data of every kind for stars down to the faintest that can practically be reached. As complete observation and treatment of these numberless stars is out of the question, the plan is confined to a set of samples distributed over the whole of the sky.

### *Conclusion.*

If, at the end of this lecture, somebody summarises what has been discussed by saying that the results about the structure of the universe are still very limited and not yet free from hypothetical elements, I feel little inclined to contradict him. But I would answer him by summing up in another way, viz.:—

Methods are not wanting which, given the necessary observational data obtainable in a moderate time, may lead us to a true, be it provisionally still not very detailed, insight into the real distribution of stars in space.

I think this time need not exceed some fifteen years. They to whom such a time may still seem somewhat long may be reminded of the fact that we shall have finished our work before any but a very few of our nearest neighbours in space can be aware of the fact that we have begun, even if we could send them a message now by wireless telegraphy travelling at the speed of light.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

ST. ANDREWS.—Besides the gifts of Diplodocus to the British Museum and to the museums of Paris and Berlin, Dr. Andrew Carnegie has, at the instigation of Dr. Holland, presented a neatly mounted example (cast) of the hind limb of Diplodocus to the University Museum, St. Andrews—another of the very munificent donations which mark the period of office of the late Rector of the University.

As the contributions toward the re-endowment of Oxford University have reached a total of more than 100,000*l.*, the second donation of 10,000*l.* promised by Mr. W. W. Astor has now been received by Lord Curzon of Kedleston, the chairman of the fund.

ON July 10 the administrative staff of the technological branch of the Board of Education will remove from South Kensington to the new offices of the Board in Westminster. All correspondence on and after July 9 should be directed to the secretary, Board of Education, Whitehall, with the exception of letters for the Victoria and Albert Museum, the Royal College of Art, and the Solar Physics Observatory, which should continue to be addressed to the offices of the Board of Education, South Kensington.

ON Tuesday, July 7, the King, accompanied by the Queen, opened the new buildings of the University of Leeds. In the course of his reply to an address presented by the Vice-Chancellor, the King said:—" My interest in the great cause of education is well known, and I note with gratification the ever-widening basis of the instruction now undertaken by our great educational institutions. The high standard of moral and intellectual discipline for which our schools and universities have been distinguished has not been lowered, nor has the pursuit of literary and historical studies been checked by the inclusion in the university curriculum of those scientific studies, and especially of those branches of applied science for which such ample provision has now been made. I rejoice to think that the opportunities open to the young men of our great industrial communities of acquiring a knowledge of subjects of commercial utility in an atmosphere of academic culture are being so greatly increased, and I find it difficult to express my appreciation of the manner in which the great responsibilities which rest with the authorities and teachers of a university such as this have been discharged. It is a source of pleasure to me to know that you have provided also for the study of the theory and practice of agriculture, for I am convinced that the best possible results cannot be derived from the industry and natural ability of our farmers unless they are properly instructed in the scientific aspects of their work." When the University was founded, the Privy Council stipulated that a building fund of 100,000*l.* should be formed, and this amount has now been raised. The new buildings include a number of independent blocks, namely:—(1) extension of main buildings, providing accommodation for arts subjects, zoology, and botany, including new botanical and zoological laboratories; (2) extension of present engineering laboratory in a separate large wing at the rear of the main building; (3) large new block of buildings for electrical engineering; (4) large new block of buildings for mining, fuel, and metallurgy; (5) large temporary building for physical laboratory and organic chemistry laboratory. Increased support from the Treasury is needed if the work provided for in these new buildings is to be carried on efficiently. We hope to give an account of the new buildings in our next issue.

## SOCIETIES AND ACADEMIES.

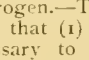
### LONDON.

**Entomological Society**, June 3.—Mr. H. Rowland-Brown, vice-president, in the chair.—*Exhibits.*—H. St. J. **Donisthorpe**: Pseudogynes of *Formica sanguinea*, caused by the presence of the beetle *Lomechusa strumosa* in the nest, from the New Forest.—H. J. **Turner**: Living larvæ of *Coleophora maritimella* on *artemisia*, and also a species of Asilidæ and its prey.—C. J. **Gahan**: (1) Living specimens of a "leaf-insect" from the Seychelles, bred in England by Mr. St. Quentin, probably *Pulchriphyllium crurifolium*, S.; (2) some Lampyridæ of considerable interest collected by Mr. E. E. Green in Ceylon, and including both sexes of the genera Lamprigera and Dioptoma, the females of which had hitherto been unknown, those of both genera being larviform. Attention was directed also to the existence in China, Ceylon, and the Malay Peninsula of remarkable larviform females greatly resembling in form the females of the American group Phengodini, and being somewhat similarly provided with rows of luminous points. G. C. **Champion**: Specimens of *Dromius angustus*, Brullé, and *Cryptophagus lovendali*, Ganglb., recently recorded by him from Woking and the New Forest respectively; also two species of the Staphylinid genus Leptotyphlus and one of the Curculionid genus Alaocyba, the exhibitor mentioning that these extremely minute blind insects were much smaller than any known British representatives of the S. European groups in question.—Colonel C. **Swinhoe**: Several boxes of butterflies taken during the present year (1908) in the Canary Islands, chiefly from Grand Canary and Teneriffe. Colonel Swinhoe observed that, with the exception of *Lycaena webbianus*, all the species met with suggest a foreign origin.—*Papers.*—Notes on the value of the genitalia of insects as guides in phylogeny: W. **Wesché**.—Certain Nycteribiidæ, with descriptions of two new species from Formosa: Hugh **Scott**.—Further studies of the Tetriginæ (Orthoptera) in the Oxford University Museum: Dr. J. L. **Hancock**.—Mimicry in tropical American butterflies: J. C. **Moulton**.—Heredity in *Papilio dardanus* from Natal, bred by Mr. G. F. Leigh, of Durban: Prof. E. B. **Poulton**.—New species of Hesperiidæ from Central and South America: H. H. **Druce**.

**Royal Meteorological Society**, June 17.—Dr. H. R. Mill, president, in the chair.—The Hong Kong typhoon of September 18, 1906: L. **Gibbs**. Judged by anemometer records, the typhoon was by no means a severe one, as the highest average hourly wind velocity was seventy miles.—An elementary explanation of correlation, illustrated by rainfall and depth of water in a well: R. H. **Hooker**.

**Chemical Society**, June 18.—Sir W. Ramsay, K.C.B., F.R.S., president, in the chair.—The thermal decomposition of hydrocarbons, part i., methane, ethane, ethylene, and acetylene: W. A. **Bone** and H. F. **Coward**. The results of a systematic investigation of the modes of decomposition of the four hydrocarbons at temperatures between 500° and 1200° were described, and it was shown that methane, which is by far the most stable of the four hydrocarbons, and a principal product of the decomposition of the other three, decomposes for the main part directly into carbon and hydrogen. The methane formed during the decomposition of the other three hydrocarbons can be explained on the supposition that "residues" such as $:CH$ and $:CH_2$ are directly "hydrogenised" in an atmosphere rich in hydrogen.—The rusting of iron: W. A. **Tilden**. It was shown that (1) oxygen or air with liquid water are alone necessary to produce rusting of iron; (2) that water alone attacks iron slowly, producing a film of what is probably ferrous hydroxide; (3) that iron rust always contains ferrous oxide; and (4) that rusting is due in the first instance to electrolytic action, promoted in all ordinary cases by the existence of carbonic acid in water exposed to the air, and by the presence in iron of various compounds of carbon, silicon, phosphorus, and sulphur.—Studies on zirconium: E. **Wedekind** and S. J. **Lewis**.—The constituents of Canadian hemp, part i., apocynin: H. **Finnemore**. The principal constituent of the root of *Apocynum cannabinum* is identical with the crystalline apocynin of commerce, which is identical with the acetovanillone obtained by Tiemann from *iso*eugenol, and

M·O

has the constitution HO  CO.CH$_3$.—A new synthesis of apocynin: H. **Finnemore**. The author has synthesised this substance from vanillin by an application of the Grignard process.—The constitution of diazonium perbromides: F. D. **Chattaway**.—Cholestenone: C. **Dorée** and J. A. **Gardner**. Cholestenone produced by the oxidation of cholesterol reacts with ozone, giving an ozonide which probably has the formula $C_{27}H_{44}O.O_7$. This, when decomposed by water, gives carbon dioxide and a ketomonocarboxylic acid, $C_{26}H_{42}O_3$, identical with that obtained by Windaus. Cholesterol on similar treatment gives an ozonide, $C_{27}H_{46}O.O_3$, which also evolves carbon dioxide on treatment with water.—Solubility of silver chloride in mercuric nitrate solution: B. H. **Buttle** and J. T. **Hewitt**. Morse's view that when mercuric nitrate is present in large excess, chlorine occurs only as $HgCl^{\cdot}$ ions, is confirmed.—The relation between absorption spectra and chemical constitution, part ix., the nitroso- and nitro-groups: E. C. C. **Baly** and C. H. **Desch**.—Benzeneazo-2-pyridone: W. H. **Mills** and Miss S. T. **Widdows**.—The electrolytic chlorination of the salts of some organic acids: J. K. H. **Inglis** and F. **Wootton**.—The action of nitrous gases on di*cyclo*pentadiene: A. **Rule**. The gaseous products from the action of nitric acid on arsenious oxide bring about the formation of a mixture which on separation by means of alcohol was found to consist of the ψ-nitrosite and the dinitro derivative of the hydrocarbon.—An alternative structure for the supposed stereoisomeric α-osazones: F. D. **Chattaway**.—The formation of 4-pyrone compounds from acetylenic acids, part ii.: S. **Ruhemann**.—The fluorescence of platinocyanides: L. A. **Levy**. Barium platinocyanide exists in two forms identical in crystalline form, but which exhibit a remarkable difference in physical properties. One variety is golden-yellow, and only very slightly fluorescent, the other being bright green and very fluorescent. The two forms have the same chemical composition, and are isomeric modifications. Similar phenomena are exhibited by the calcium salt, and to a certain extent by the cerium salt.—The preparation of disulphides, part ii., the action of alkalis on sodium alkyl thiosulphates: T. S. **Price** and D. F. **Twiss**. The interaction between alkalis and sodium ethyl and benzyl thiosulphates in aqueous solution has been studied. The chief organic product of the action in each case is the corresponding disulphide, the main step of the reaction being probably represented by the equation

$$R.S_2O_3Na + NaOH = RS— + Na_2SO_3 + —OH.$$

—Note on the formation of lead ethoxide: F. M. **Perkin**. When thin sheets of lead are boiled in alcohol or suspended in the vapour of boiling alcohol no action takes place, but if they are suspended over absolute alcohol and ozone is bubbled through it, in a short time the surface of the lead becomes tarnished, and then assumes a brownish-yellow colour due to the formation of lead ethoxide, $Pb(OEt)_2$.—Some reactions of phenylhydrazine with metallic cyanides and other salts: R. de J. F. **Struthers**. Phenylhydrazine in alcoholic solution combines with cuprous cyanide in ammoniacal solution to form an insoluble compound, $2CuCN,3C_6H_5.NH.NH_2$. Cobalt cyanide exerts a powerful catalytic action on phenylhydrazine, 0·03 gram to 0·04 gram sufficing to determine the decomposition of 5 c.c. or 6 c.c. of phenylhydrazine with almost explosive violence. Nickel cyanide has a similar but less powerful action.—The formation of polyiodides in nitrobenzene solution, part iii., the chemical dissociation of the polyiodides of the alkali metals and ammonium radicals: H. M. **Dawson**.—The hydrolysis of amygdalin by emulsin, part ii.: S. J. M. **Auld**. It is shown that amygdalin is derived from an αβ-disaccharide, the β-dextrose residue being attached to the benzaldecyanohydrin nucleus. Mandelonitrile glucoside is formed as an intermediate product during the hydrolysis of amygdalin by emulsin, the biose ether-linking breaking preferentially.—A new form of potash bulb: A. E. **Hill**. This is figured in the Proc. Chem. Soc., xxiv., 182.

EDINBURGH.

**Royal Society**, June 15.—Dr. R. H. Traquair, vice-president, in the chair.—The reducing action of electrolytic hydrogen on arsenious and arsenic acids when liberated from the surface of different metals: W. **Thomson**. The hydrogen liberated from the five metals lead, zinc, cadmium, tin, and silver converted arsenious acid ions into arseniuretted hydrogen with about equal velocity. The reaction could be measured during small intervals of time, and the velocity of reaction was practically that of a unimolecular reaction. Arsenic acid was much more difficult to reduce than arsenious acid. Lead, however, converted it into arseniuretted hydrogen with a velocity nearly equal to that with which it reduced arsenious acid. Zinc, with a higher supertension equivalent, reduced it at only about a third of the velocity, whilst silver reduced none at all under the conditions of the experiment.—The theory of the microbarograph, and on some observations with the Dines-Shaw instrument: Prof. **Chrystal**. The mathematical theory, which was an application of the laws of viscosity of gases, showed that with external pressure increasing at a steady gradient the microbarograph tended to a maximum, that a wave-like variation of pressure was recorded on the instrument with the crests and troughs preceding in time the corresponding rounded crests and troughs in the external variation, but that with a sharp, abrupt change in the rate of change of the pressure the corresponding pinnacles and troughs on the instrumental record occurred simultaneously with the external changes. Observations had been made at three stations in the neighbourhood of Lochs Tay and Lochearnhead with the object of measuring the rate of progression of rapid oscillations of pressure across the district. It was found that the majority of these were from the west, in this respect resembling cyclonic depressions, and that their speeds of progression also varied within much the same limits which characterised the progression of cyclones.—The effects of chloroform on the metabolism: Prof. Noel **Paton**. The object of the paper was to study the conditions under which late chloroform poisoning occurred. From a series of experiments on the administration of chloroform to dogs by the respiratory passages, by the stomach, and under the skin, the conclusions were drawn that when given by the mouth and hypodermically chloroform acted as a poison, decreasing the activity of the liver, but that when administered through the respiratory passages it increased the disintegration of the protein in the body and stimulated the liver. The reason of this was demonstrated in a second paper, by Miss Dorothy **Lindsay** and Prof. **Paton**, in which it was shown that chloroform given by the lungs was rapidly taken up and rapidly eliminated, but when administered by the other methods it was slowly taken up and slowly eliminated, and got fixed to the liver in large quantities.—Asteroidea, Ophiuroidea, and Echinoidea of the Scottish National Antarctic Expedition: Prof. **Koehler**. Of the ninety-four species collected, seventy-six were records from Antarctic and sub-Antarctic regions, including forty-one new species and two new genera.—Holothuroidea of the Scottish National Antarctic Expedition: Dr. Clement **Vaney**. Of the thirty-four species described twenty-one were new. Nearly all the new species are from very high southern latitudes, and from depths of 1400 to 2600 fathoms. Both these papers were communicated by Dr. W. S. Bruce.

PARIS.

**Academy of Sciences**, June 29.—M. Bouchard in the chair.—Observation of the partial eclipse of the sun of June 28, 1908, at the Observatory of Paris by various observers: B. **Baillaud**. Observations were made of the contacts and length of the common chord of the two discs, and numerous photographs were taken. The observers were MM. Bigourdan, Schaumasse, Chatelu, Popoff, Puiseux, and Baillaud.—Decomposition of the alcohols under the catalytic influence of wood charcoal (braise de boulanger): Georges **Lemoine**. Details are given of the products obtained by the catalytic decomposition of methyl, ethyl, normal propyl, isopropyl, and isobutyl alcohols in presence of charcoal. The results varied somewhat with the nature of the charcoal employed, but the main reaction was the production of hydrogen and the aldehyde, differing from the reaction with purified animal charcoal, the latter giving chiefly water and the corresponding olefine. The temperatures at which the decompositions took place were considerably lower than those at which the alcohol was decomposed in the absence of charcoal.—A new mineral species and the minerals which accompany it in the tourmaline layers of Madagascar: A. **Lacroix**. The new mineral is a silicate of aluminium, calcium, beryllium, magnesium, lithium, sodium, and potassium, the formula proposed from the analyses being

$$10SiO_2,8Al_2O_3,5 \cdot 5(Ca, Be, Mg)O,1 \cdot 5(Li, Na, K)_2O,7H_2O,$$

and for which the name bityite is proposed.—A new rheograph designed for the projection of the curves of alternating currents: Henri **Abraham** and J. **Carpentier**. The instrument is on the lines of one described in 1897, and is distinguished by the fact that its moving parts are relatively heavy, and capable of carrying a mirror of large surface. A demonstration of the apparatus was given before the academy.—Electrocapillary measurements by the method of large drops: M. **Gouy**. The capillary electrometer giving only relative figures, the present paper is concerned with absolute measurements. The drop of mercury must be rigorously hemispherical, and this was secured by carrying it in a glass vessel, optically worked, of 40 mm. radius. Results are given for solutions of sulphuric acid, sodium sulphate, hydrochloric acid, and the iodide and bromide of potassium.—The action of metallic oxides on the primary alcohols: Paul **Sabatier** and A. **Mailhe.** The oxides examined fall into four groups:—(1) not undergoing reduction, and exerting no appreciable effect on the primary alcohols under 400° C.; (2) those rapidly reduced by the alcohol to the metal or lower oxide; (3) those which are not reduced, but decompose the alcohol catalytically into aldehyde and hydrogen, or ethylenic hydrocarbon and water; (4) oxides slowly reduced, exerting a catalytic action. The detailed results will be given in a later paper.—Observations on the sun made at the Observatory of Lyons during the first quarter of 1908: J. **Guillaume.** Observations were made on forty-one days, and the results are given in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—Ruled surfaces: A. **Demoulin.**—The canonical products of infinite genus: Arnaud **Denjoy.**—The partial differential equation of vibrating membranes: M. **Sanielevici.**—The existence of spark lines (enhanced lines) in flames at various temperatures, and on the modifications which they undergo: G. A. **Hemsalech** and C. **de Watteville.** The intensity of numerous iron lines has been studied by the authors' method in flames of different temperatures (air-coal gas, oxygen-coal gas, and oxygen-hydrogen), and it is found that the spark lines are most marked in the coolest flame, air-coal gas, and hence it is concluded that the action of the temperature cannot be considered as the fundamental factor in the production of the enhanced lines.—The preparation of the alkaline chloroiridites: M. **Vèzes.** A claim for priority against M. Marcel Delépine.—The molecular weights of the phosphoric acids determined by cryoscopy: H. **Giran.** The molecular weights found in acetic acid solution fall with the age of the solution; the true molecular weight for each acid at the moment of solution is deduced from a time curve. The formula deduced from these experiments for metaphosphoric acid is $5(HPO_3)$, for pyrophosphoric acid $3(H_4P_2O_7)$, and for orthophosphoric acid $2(H_3PO_4)$.—The magnetic oxides of chromium: Ivan **Shukoff.** From the magnetic properties of the mixture of oxides obtained by gently heating chromic anhydride, there would appear to be a magnetic oxide of chromium of the composition $Cr_4O_9$.—The tellurides of arsenic and bismuth. The cryoscopic constant of tellurium: H. **Pélabon.**—The mechanism of the synthesis of the cyclic nitrogen compounds: L. J. **Simon.**—The method of Messinger and Vortmann for the estimation of some phenols. The separation of salicylic acid: J. **Bougault.** By the action of iodine and an alkali upon salicylic acid, a red, insoluble substance is produced, which can be used for the quantitative determination of salicylic acid.—Three new primary alcohols resulting from the condensation of sodium benzylate with propyl, butyl, and isoamyl alcohols: Marcel **Guerbet.**—Researches on *bis*-azoic compounds: H. **Duval.**—The products of condensation of *ortho*- and *para*-nitrobenzyl chloride with acetylacetone: M. **Mech.**—The origin of the colouring matter of red grapes and other vegetable organs: J. **Laborde.**—The oxidation of eugenol by the oxidising ferment of fungi and by perchloride of iron; the preparation of dehydroeugenol: H. **Cousin** and H. **Hérissey.** Oxidation of eugenol both by ferric chloride and by the biochemical method gives a new phenol, dehydrodieugenol, the acetic and benzoic esters of which are described.—The influence of certain combinations of iron compared with the peroxydases in the catalysis of hydriodic acid by hydrogen peroxide: J. **Wolff** and E. **de Stœklin.**—The influence of the temperature of sterilisation of must and that of fermentation on the bouquet of wines: A. **Rosenstiehl.** Both the temperature of sterilisation and of fermentation of must can be lowered with advantage to the quality of the wine produced.—The comparative development of tubercles and roots: G. **André.**—The development of the notochord in the bony fishes: Louis **Roule.** From a study of the development of the notochord in the common perch (*Perca fluviatilis*), the author comes to the conclusion that there is not a complete homology between the notochord of Vertebrates and Tunicates.—Bulbular epistasy of nasal origin: Pierre **Bonnier.**—The geology of eastern Corsica: Pierre **Termier** and Eugène **Maury.**—The rameal origin of ulodendroid cicatrices of *Bothrodendron punctatum*: Armand **Renier.**—Report of the committee appointed to consider the distribution of the Bonaparte fund for 1908.

NEW SOUTH WALES.

**Linnean Society,** April 29.—Mr. A. H. S. Lucas, president, in the chair.—A revision of the Australian species of Adelium (Coleoptera): H. J. **Carter.** When Blessig reviewed the Australian Heteromera in 1862, fifteen species of Adelium were recognised. In the meantime, the number of described species has increased to eighty. The opportunity of comparing his collection with types in the British Museum and in the Paris and Brussels Museums during a recent visit to Europe had enabled the author to submit the species to a critical revision, the outcome of which is a proposed reduction of the number to fifty-four, by the reference of ten species to other genera, and the omission of synonyms. It is also noted that the so-called species of Adelium of New Zealand and New Caledonia belong to different genera, so that it is probable that the genus Adelium is confined to Australia and Tasmania.—A revision of the Thynnidæ (Hymenoptera) of Australia, part ii.: R. E. **Turner.** Part ii. of the revision deals with the genus Thynnus. The species are very diverse in appearance and structure, but it is thought to be best, in the present state of knowledge, to group them in subgenera rather than to propose an excessive number of new genera, some of which might have to be sunk when additional material is available. The Australian species number 213, and fall into ten subgenera.

## CONTENTS.

THURSDAY, JULY 16, 1908.

## EXPERIMENTAL ENTOMOLOGY.

*Experimentelle Entomologische Studien vom physikalisch-chemischen Standpunkt aus.* By Prof. P. Bachmetjew. Zweiter Band; mit 25 Tafeln. Pp. xvi+944+cviii. (Sophia: Staatsdruckerei, 1907.)

ALTHOUGH it is well known that many excellent observers have of late years devoted their attention to experimental work of which insects are the subject, it is probable that few students of entomology have realised hitherto how large is the mass of material that has now been accumulated in this department of research. The present work is somewhat of a revelation. Its tale of nearly a thousand pages consists almost entirely of a condensed account of the investigations conducted by various experimenters on the influence of external factors on the phenomena of insect life. Even so, the list is not quite complete, for, though the author, working under many difficulties, has displayed an amount of industry in collecting his material that is really astonishing, we could yet name more than one memoir bearing on the subject that seems to have escaped his vigilance. We note, for example, the omission of any reference to the striking experiments of Mr. G. A. K. Marshall on South African Lepidoptera. Nevertheless, the compilation has, on the whole, been admirably executed, and Prof. Bachmetjew's bulky volume will be indispensable to those workers in the subject who wish to have the results of nearly all previous investigations in a readily accessible form. The amount of labour saved to his colleagues in entomology by the author's determination to record every relevant fact hitherto ascertained by experiment is quite incalculable.

The work is divided into two parts, the first dealing with the actual results obtained by various investigators, the second giving the theoretical conclusions considered by these and other authorities to be warranted by the experiments in question. As might be expected, these speculative opinions are of very unequal value, and it is to be observed that the author makes little or no attempt to decide between them when they are contradictory, or to condemn them when erroneous. He has rather set before himself the task of recording without distinction, not only every fact relating to his subject, but also every conclusion at any time suggested, whether the latter be good or bad. His own views, save on a few points, are not much in evidence. It is clear from this that the book has serious limitations; these, however, do not prevent it from being extremely useful within the scope allowed it by its author. The insects dealt with naturally belong almost entirely to the order of Lepidoptera.

The effects of the various external factors are considered in their relation to the time occupied in development, to the size and form of the perfect insect, and to its ultimate colouring and pattern. Under each of these main heads the influence is considered of climate, moisture, temperature, light, the colouring of the surroundings, food, including chemical food-material artificially employed, electricity, magnetism, friction, artificial constriction, pressure, gravitation, and other factors.

The author defers to a future treatise the questions of seasonal dimorphism, protective resemblance, mimicry, and parthenogenesis. The omission of these subjects, especially of the first three, marks a further limitation of an important character, for they often have a special bearing on the interpretation of such facts as are here recorded. Indeed, inasmuch as an appreciation of the significance of the changes induced by the operation of external factors is often entirely dependent on a knowledge of the insect in question in its relation to seasonal, mimetic, and cryptic conditions, the present treatise, useful as it is, can only be considered as a partial introduction to the theory of the subject.

The book is fitly dedicated to Dr. Max Standfuss, of Zürich, whose experiments, conducted on a very large scale, have, perhaps, done more than those of any other investigator to establish our knowledge of the effects of temperature applied during the immature stages on the form and colouring of the perfect insect. His experiments in hybridisation, although carried out before attention had been generally directed to the epoch-making work of Mendel, are also very worthy of note. Next to Standfuss's experiments, perhaps the most important work of this nature is that conducted through many years by Mr. F. Merrifield at Brighton, and we are glad to see that due prominence is given to his admirable investigations in Prof. Bachmetjew's pages. Among other work carried out by English experimenters is that of Prof. Poulton, which also comes in for appreciative notice, but here we cannot fail to observe the somewhat unfortunate effect of the author's determination to reserve the question of protective coloration for future treatment. Much of the significance of Poulton's results on the effect of surrounding objects on the colouring of larvæ and pupæ is thus for present purposes lost. It is from their bearing on evolutionary problems that data of this kind derive their highest interest, and we must once more remark on the opportunities thus missed by the author. We may hope, however, that the omission is only of a temporary character, and that we shall yet see a treatise from his hand which will throw fresh light on many questions of primary importance in the study of evolution.

The plates consist for the most part of graphic representations of the statistical results furnished by the tables in the body of the work. They are useful as exhibiting series of facts in a form which by most people is more easily appreciated than a bare numerical statement.

It will have been gathered from the foregoing remarks that Prof. Bachmetjew's volume is mainly designed as a work of reference. In accordance with this plan, the literature of the subject has been very carefully catalogued, and the bibliography, which occupies seventy-seven pages at the end of the book, besides occasional lists given in the text, is of a very full description. It is true that there are omissions, but these do not appear to be numerous.

The author is already favourably known for his excellent *résumé* of observations and experiments relating to temperature in insects, this, with the present volume, constituting the first two instalments of his projected "Experimental Studies in Entomology." The production of the third volume of the series will be awaited with interest. F. A. D.

## INFINITE SERIES.

*An Introduction to the Theory of Infinite Series.* By T. J. I'A. Bromwich. Pp. xvi+511. (London: Macmillan and Co., Ltd., 1908.) Price 15*s.* net.

THE first impression this book is likely to produce is that, considering its title, it is very big. However, it is not diffuseness that is to blame for this; the fact is that quite a third of the volume consists of matter that does not strictly come under the title, but is either introductory or supplemental. Thus we have an appendix dealing with irrational numbers and limits; another on logarithms and exponentials; a third on infinite integrals and gamma functions.

It is pleasant to find the author adopting Dedekind's definition of an irrational number, the only one which is really scientific. In the second appendix, the exponential function is introduced after the logarithm, but as the latter is defined by an integral, this does not matter much. There can be little doubt that for methodical treatment, the integral definition of $\log z$, with the elements of the theory of complex integration, is by far the most satisfactory; and it does not introduce any gratuitous difficulties. The third appendix is interesting, because it introduces recent results obtained by the author, Mr. Hardy, and others, which illustrate very clearly how the problems of series are complicated when we pass to integrals over an infinite range. In passing, it may be observed that Mr. Bromwich refers with due appreciation to Mr. Gibson's excellent text-book on the calculus.

Passing on to the main subject of the book, it is curious to note how much there is that is comparatively recent. Of course, Abel and Cauchy were the great pioneers; but if we take, for instance, the distinction between uniform and non-uniform convergence, this does not seem to have been fully recognised before Stokes's paper of 1847 (see Mr. Bromwich's note, p. 115); and the new definitions of the "sum" of a divergent series are creations of yesterday.

The subject last mentioned is discussed in chapter xi., mainly after Borel and Cesàro, and is a good example of the extension of mathematical terms. Borel gives a process by which, from a divergent series (or sequence) $\Sigma$, we can in certain cases find an expression $S(\Sigma)$ which is finite. Moreover, if $\Sigma$ is a convergent series, $S(\Sigma)$ is the sum in the ordinary sense, and if $S(\Sigma)$, $S(\Sigma')$ exist, then $S(\Sigma+\Sigma')=S(\Sigma)+S(\Sigma')$. Mr. Bromwich makes some very interesting comparisons between this recent theory and some of Euler's transformations of divergent or oscillating series. Like Fourier, Euler had a wonderful instinct, which led him right, even when his logic was defective.

It is fairly plain that, with the exception of convergent series, there is no one definition of the sum superior to all others; different definitions may be useful for different purposes. Again, with regard to ordinary series, there is no universal test for convergency, except, of course, the definition; and the same remark applies to integrals with infinite limits. Oddly enough, one of the most useful tests for the convergence of a series (p. 35) is practically due to Gauss.

One of Mr. Bromwich's great merits is that he constructs examples to show the fallacy of various plausible assumptions which have occasionally misled even the elect. For instance (p. 99), we have a product $\Pi(1+u_n)$ which is convergent, although $\Sigma u_n$ and $\Sigma u_n^2$ both diverge. The discussion of double series is also very instructive. The fact is that any actual case of summation is the construction of a linear sequence $s_1$, $s_2$, $s_3$, &c.; so-called derangements or permutations of series are best regarded as constructions of new series, the terms of which have a one-one correspondence to those of the first. Two series thus related may, or may not, have the same sum.

Attention should be directed to the discussion (pp. 157–60) of certain Fourier series, especially as to the limiting form of the curve

$$y=\sin x+\tfrac{1}{2}\sin 2x+\ldots+n^{-1}\sin nx,$$

when $n$ increases indefinitely. Reference might have been made to the correspondence in NATURE, vol. lix. (1898), in which Willard Gibbs and Prof. Michelson took part. The point is that the limiting form is not a mere zig-zag but a zigzag with projecting spines.

Finally, a word may be said about the examples, which are very numerous and diversified. It is perhaps a trifling matter in itself, but to some minds it will give satisfaction, that as modern analysis is becoming assimilated, illustrations of it are being produced which have something of the elegance and individual beauty of the Cambridge or Oxford problem of years gone by. After all, a plant must grow before it flowers. G. B. M.

## STUDIES IN EDUCATION.

*The Demonstration Schools Record.* Being Contributions to the Study of Education by the Department of Education in the University of Manchester. No. 1. Edited by Prof. J. J. Findlay. Pp. xvi+126. (Manchester: The University Press, 1908.) Price 1*s.* 6*d.* net.

THE work before us is to be regarded rather as an introduction to future issues of the "Record" than as an arranged and classified record of the results of educational observation and experiment. Here the authors take us into their confidence; we are told what their view of a demonstration school is, what questions they hope to solve, and on what principles they think the answers should be sought. When the future volumes are available the record will be one in which full confidence can be placed; it will not be a statement of partial facts selected consciously or unconsciously to fit a particular theory. For this reason, as well as for the clear statement of some of the educational problems involved, those interested in educational progress will give the volume a cordial welcome. At the same time, it seems a little doubtful whether such facts should be published as that not only the mental achievements, but the "nature, instincts, experience, *and ideals*" of each child are noted and tabulated by the students in training. The files are no doubt kept with scrupulous privacy under lock and key. But if through parents buying the book and leaving it about, or talking about it, the children get to know of this dissection, the injury to character might be serious.

The general scheme of the school work will have the full approval of modern educationists, who will envy Prof. Findlay and his colleagues the opportunity of putting their theories into practice. Particularly valuable are Prof. Findlay's observations on the relation of the school to civic and corporate life, and especially his conviction that the parents are to be brought into the closest possible touch with the educational as well as the social aspects of the school work. It is indeed only when we have educated the parents that we can hope to have the full measure of success in educating the children.

As to details, the scheme of science teaching seems excellently conceived. That of French shows careful work in accordance with the direct method, the psychology of which is so well explained by Prof. Findlay's paper (reproduced p. 69). It is to be hoped that in future issues the relation of practice to theory will be dwelt on; for instance, one wants to know *how* "the general efficiency of the school *in other departments* affects vitally the success or failure" of the French teaching (p. 71). The scheme for history and handwork combined has at least the merit of boldness. With the object of increasing the sympathy with social rather than personal interests, biography has been discarded, and interest in the material world takes its place until the children are nine years old. From six to seven some elementary facts about the food, clothing, housing, &c., of present-day life are taught, with practical applications. From seven to nine the children are "prepared for more systematic study of the historical beginnings of the nation to which they belong" by being made to imagine themselves first as Tree-people, then as Cave-dwellers, then as Red Indians, then as pastoral tribes, and lastly as Saxons, and there is plenty of scope for handwork in reproducing the material conditions of the life of the different periods. Then, judging from the record, it would seem that at nine they are plunged straight into the *details* of the history and literature of the period from 1625–1660. For 1908 this was apparently the course for all children from nine to fourteen years of age.

The chapter on the social aspects of child study is not convincing, and scarcely seems to have been written in such close contact with the life of the school as the others. It shows a tendency to vague language and uncertain generalisations which seem out of place in the record of a demonstration school.

It is legitimate to hope that the future volumes will answer more of the questions they raise.

## ELEMENTARY ELECTRICITY.

*An Introduction to Electricity.* Being a translation of the second edition of "Einfuhrung in die Elektrizitatslehre," with corrections and additions by author. By Bruno Kolbe. Translated by Joseph Skelton. Pp. xii+430. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1908.) Price 10*s.* 6*d.* net.

THE editor offers this volume as a satisfactory introduction to the science, both for students and for "the man in the street." So far as the former is concerned, the claim may be dismissed at once; the book is too inaccurate; and the "man in the street" must have a remarkable mind if he gets what he wants from Prof. Kolbe. We should have imagined that he required a clear statement of principles, and was not greatly concerned with experimental evidence. Prof. Kolbe gives him an overwhelming mass of experiment—(it is only fair to say that the experiments are often highly ingenious)—accompanied by confusing and misleading deductions.

Comprehension is rendered more difficult by the failure of the translator to eliminate the syntax of the original. We may be misrepresenting the author, but the following argument appears to be a simplified form of his treatment of the fundamental conceptions, charge, potential and capacity. Unit charge is defined as that on a certain proof ball after contact with a certain conductor charged to its spark potential. Successive charges are communicated to an electroscope, and a scale defining the magnitude of charges is graduated. The electroscope is then connected by a wire to various points of a charged conductor; the constant reading is defined as the "degree of electrification" (potential) of the conductor. It will be noted that in order that these definitions may agree with those used in stating the fundamental theorems, the capacity of the electroscope must be infinite in comparison with that of the proof ball, and infinitesimal in comparison with that of any conductor of which the potential is to be measured. After a long digression we come to capacity, for which two electroscopes measuring potential are required. The author appears to graduate the scales as before, and to assume that similar readings denote similar "degrees of electrification"; of course they will do so only if the capacities of the electroscopes are the same. After another chapter and a half we find the ordinary definitions of charge and potential; the former is shown experimentally to agree with that adopted previously (experimental complications are unknown to the fortunate author); but though the quantitative agreement of the latter with "degree of electrification" is asserted and assumed subsequently, no attempt is made to prove it. No indication is given of the connection of potential with field strength. In rejecting symbols, Prof. Kolbe appears to have rejected the whole of the logic of which those symbols are the ordinary expression.

Two glaring blunders should be noted in the same part of the book. The author tries to prove that there can be no charge inside a solid conductor without assuming the inverse square law; of course the proof is fallacious. He also states that the action of a flame in discharging an insulator is similar to that of points on a conductor.

The remainder of the book is much better than the portion on electrostatics; but there are several errors, and, as usual, the author tries to cover too much ground. When will authors realise that there is no royal road to learning in science or elsewhere? If those who have special aptitude for these studies require years of work to grasp the fundamentals of electricity, is it likely that the "plain man" will get any good from reading 400 "elementary" pages attempting to deal with the whole subject? Such publications only increase the number of persons who talk and write about things of which they imagine themselves masters, but are in reality ignorant.

## OUR BOOK SHELF.

*Handbook of Flower Pollination, based upon Herman Müller's Work "The Fertilisation of Flowers by Insects."* By Dr. P. Knuth. Translated by Prof. J. R. Ainsworth Davis. Vol. ii. Pp. viii+703. (Oxford: Clarendon Press, 1908.) Price 31*s*. 6*d*. net.

As stated in our review of the first volume (vol lxxiv., 1906, p. 605), Knuth's "Handbook of Flower Pollination" is an encyclopædic work, and the second volume, which is now before us, dealing as it does with the various methods of pollination in fifty-six families of dicotyledonous plants, is even more directly a book of reference than the first volume, which was of an introductory nature. In this second volume the author deals seriatim with all the genera and species in the natural orders under consideration, describes the structure of the flowers in so far as it affects directly or indirectly the mode of pollination, and cites the various direct observations on pollination made by himself or others. To each species of plant is appended a list of the insects which have been observed visiting the flowers, together with a statement as to whether the insects in question were devouring or collecting pollen or sucking nectar.

The translator has facilitated the use of the volume, which will be more frequently consulted than read through, by repeating more fully the titles of the books and papers referred to than is the case in the original. Few, if any, of these references are more recent than 1898, the date of publication of vol. ii. in the German edition, though the list of references in the first volume of the translation is brought up to 1904.

No doubt the labour involved in bringing up to date the various recorded visits of insects to flowers would have been very considerable, but on points of a more general character the translator might have added some additional information in the form of footnotes. Thus in dealing with those Papilionaceæ which have so far been recognised as self-sterile, the translator might have mentioned the more recent investigations of Kirchner, and might have referred to the illuminating generalisation of that author, who found that while so many perennial Leguminosæ are self-sterile, all the self-fertile forms of Papilionaceæ are annuals which are dependent for their continued existence on each year's successful crop of seeds, and cannot, therefore, afford to be self-sterile. Similarly, in dealing with the genus Alchemilla, mention might have been made of the recent investigations of Strasburger and others on the phenomenon of apogamy so characteristic of a certain section of this genus.

A useful improvement is the addition to the translation of a list of the natural orders dealt with in this volume, which will be as welcome to English readers as the more general introductory volume has proved itself to be.

*The Theory of Ions: a Consideration of its Place in Biology and Therapeutics.* By Dr. W. Tibbles. Pp. ix+131. (London: Rehman, Ltd., 1908.) Price 2*s*. 6*d*. net.

This is a bright little book written with the object of pointing out the bearings of physical chemistry on physiological processes. Dr. Tibbles, however, like Pauli, from whose book copious quotations are made, is rather inclined to make the phenomena of ionisation and the behaviour of colloids explain too much. There is no doubt that physical chemistry will in the future make clear a good deal of what is at present obscure in bio-chemistry; but a full appreciation of this effect cannot be gained until two things have occurred; one of these is a settling of the many vexed points of quite a fundamental nature between the physical chemists themselves, and the other is a fuller knowledge of the chemistry of protoplasm in general and of the protein constituents of protoplasm in particular.

At the present day there is probably only one sentence in the book with which all will be in agreement, and that is, "We are far from a satisfactory insight into the nature of the effect of ions."

The author gives a fairly accurate account of the advances recently made in physiological chemistry, although it will probably be found too compressed to appeal to any but those fully up in the subject. His nomenclature is not uniform, and is therefore confusing to the reader; thus he sometimes speaks of proteins, sometimes of proteids; in some places of amino- and in others of amido-acids; there are a number of uncorrected press errors, for instance, glycyl-glycyl for glycyl-glycine. The close similarity of the words absorption and adsorption should have rendered him especially careful in proof-correcting, especially where both are mentioned on the same page. He also gives us the rather startling information that choline is present in bile salts.

The work does not profess to contain anything original; it is rather a compilation from previous writers strung together with the object of emphasising the importance of a knowledge of solutions in the elucidation of physiological, pathological and therapeutical problems. Dr. Tibbles is not always judicious in his selections or judicial in their valuation. For instance, the old theories of Pflüger, Latham, Loew, and others on the distinction between living and dead proteins are all advanced as though they were still tenable and of equal value with the views of Fischer which depend on actual work and not on mere speculation.

Still, the book is interesting, and contains many suggestions of importance, but the author has not realised that it is not possible to write a complete text-book of organic chemistry, bio-chemistry, physical chemistry, therapeutics and immunity within the short compass of 130 small pages, or that the ionic theory or any other theory, however new and attractive, is sufficient to explain the universe.

*The Libraries of London: A Guide for Students.* Prepared by R. A. Rye. Pp. 90. (London: The University of London, 1908.) Price 6*d*. net, post free 9*d*.

The libraries described in the book, with the exception of those of certain schools of the University, and that of the Royal Botanic Gardens, Kew, lie within the London County boundary. The information about each of the very large number of London libraries is just what a student wants to assist him in his search for books on a particular subject. Few persons, unless they have made special inquiries, can have any idea of the immense number of books available in London for reference by the seeker after knowledge or recreation. Students owe a debt of gratitude to the Senate of the University of London for giving instructions for the preparation of this guide, and to Mr. Rye for his complete understanding of their needs.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### The Spectrum of Radium Emanation.

In Nature of July 9 a letter from Prof. Rutherford appears giving an excellent corroboration of measurements of the spectrum of radium emanation which we communicated to the Royal Society on July 1. There can, therefore, be no doubt of the accuracy of Prof. Rutherford's measurements. When Mr. Watson, who is engaged in measuring accurately with a 10-foot grating the secondary spectrum of hydrogen, has finished his task, we shall be able to introduce some small corrections in our figures.

William Ramsay.
A. T. Cameron.

University College, Gower Street, London, W.C., July 9.

### The Kinetic Energy of the Ions emitted by Hot Bodies.

In a paper communicated to the American Physical Society at the New York meeting on February 29, the writer, in collaboration with Dr. F. C. Brown, showed that the part of the translational kinetic energy of the negative ions emitted by hot platinum, which depends on their component of velocity normal to the emitting surface, has the same mean value as the corresponding quantity for a molecule of gas at the temperature of the metal, and, further, that that component of the velocity is distributed among the different ions according to Maxwell's law of distribution of velocity among the molecules of a gas. Since then Dr. Brown has succeeded in showing that the same laws hold for the positive ions emitted by hot platinum.

Using a different method, the writer has succeeded in measuring the portion of the kinetic energy of the ions which depends on their component of velocity parallel to the emitting surface. Within the limits of experimental error, this quantity has the same mean value, for both positive and negative ions, as the corresponding quantity for a molecule of gas at the temperature of the metal, and is distributed among the different ions according to Maxwell's law.

Taken together, these investigations show that the ions emitted by hot platinum, under normal conditions, are identical, as regards their kinetic properties, with the molecules of a gas of the same molecular weight, at the temperature of the metal. It follows, by an application of the kinetic theory of gases, that the same thing holds for the free electrons inside the metal. This result has an important bearing on the electron theory of metallic conduction and of the emission of electromagnetic radiation by hot bodies.

This is the first direct experimental confirmation of Maxwell's laws relating to the distribution of velocity among a collection of moving particles in a state of statistical equilibrium.

The full account of these researches will shortly appear in the *Philosophical Magazine*.

O. W. Richardson.

Princeton, N.J., July 3.

### Absorption of X-Rays.

Some of the most interesting observations made in the investigation of the properties of homogeneous beams of Röntgen radiation are those exhibiting the connection between the absorption of X-rays and the emission of secondary X-rays from the absorbing substance. Many elements—probably all—when subject to a suitable primary beam, are the source of a homogeneous Röntgen radiation which is characteristic of the element emitting it. The following conclusions concerning the emission of this radiation have been found to be perfectly general, so far as experiments have been made.

When a very absorbable primary radiation is incident on a given element, the homogeneous radiation characteristic of that element is not emitted in appreciable intensity.

As the general penetrating power of the primary radiation is gradually increased, the absorption decreases only up to a certain point. When the penetrating power becomes greater than that of the radiation characteristic of the absorbing element, the absorption of that primary radiation begins to increase, and a secondary homogeneous radiation begins to be emitted. Then there is a rapid and considerable increase in both the absorption of the primary rays and in the emission of secondary rays. When the general penetrating power is increased still further, the absorption decreases again in the usual way, and the intensity of secondary radiation decreases at the same rate —in some cases at least—as the ionisation produced by the primary beam in air.

The special absorption of the primary rays thus connected with the emission of secondary rays is a considerable fraction of the total absorption—thus in iron the increase is about double the absorption previous to the emission of the rays.

Experiments have not been made to determine if all the extra energy absorbed appears as energy of secondary radiation, but from observations of the absorbability of the secondary radiation and of the ionisation it produces, it appears probable that a large proportion is re-emitted.

The energy re-emitted in the form of a radiation of more absorbable type is in some cases sufficient to make the total ionisation produced in an electroscope placed immediately behind a thin absorbing sheet of metal greater than that produced by the direct unabsorbed primary beam.

The emergent radiation is then a mixture of two homogeneous radiations, the proportions of which depend principally on the coefficients of absorption of the incident radiation, and of the radiation characteristic of the metal in the metal itself, the coefficient of transformation of one into the other type of radiation, and the thickness of the absorbing plate. A copper radiation may, by transmission through an iron plate, be transformed so completely as to be almost indistinguishable from pure iron radiation, but it does not then proceed in the direction of propagation of the incident radiation; it is emitted from the atoms in approximately equal intensity in all directions.

What has previously been described as the special power of a homogeneous radiation of penetrating the element emitting it and elements of neighbouring atomic weight (Phil. Mag., September, 1907, p. 408) may be more precisely stated thus:—A radiation which is more absorbable, equally absorbable, or only slightly more penetrating to most substances than the radiation characteristic of the element upon which it is incident, is absorbed much less than one of more penetrating type. It also produces little or none of the characteristic secondary radiation which is produced by the more penetrating radiation.

The special power of an ordinary heterogeneous primary radiation after transmission through an absorbing substance of penetrating further layers of that substance is due to two causes—(1) the special absorption of those radiations capable of stimulating a homogeneous secondary radiation, (2) the superposition on the primary radiation of that secondary radiation.

A full account of these experiments and a discussion of the results will be published shortly.

C. G. Barkla.
C. A. Sadler.

Liverpool, July 8.

## The Form of Birds' Eggs.

In NATURE of June 4 (pp. 111–3), in a paper by Prof. D'Arcy Wentworth Thompson read before the Zoological Society, April 28, the way in which form in birds' eggs is to be accounted for is discussed. Referring to the accepted causes of variation in form of eggs, Prof. Thompson says:—"Whatever truth there be in these apparent adaptations to existing circumstances, it is only by a very hasty logic that we can accept them as a *vera causa* or adequate explanation of the facts; and it is obvious to my mind that in attempting to deal with the forms assumed by matter, whether in the organic or the inorganic world, we ought first to attempt to deal on simple physical lines with the forces to which it has been subjected, that is to say, the intrinsic forces of growth acting from within, and the forces of tension and pressure that may have acted from without."

In other words, for the antecedent cause (adaptation to surroundings) is substituted modification resulting therefrom or the consequential cause; and far from it being "very hasty logic" to assume the former, it is, to my mind, hasty logic to rule it out and to substitute for it an *effect*. In any case, the consequent is not a "*vera causa* or adequate explanation," as must at once be apparent. Again, force or energy determines the "forms assumed by matter"; and in a question of this kind we cannot compare the inorganic and organic worlds, since in the latter we find conscious effort and thought an attribute, so far as we know, not applicable to the former, and in causation either can play a very effective part. In regard to adaptation to surroundings or influence of external conditions, which to all is not meaningless, we may state the following premises:—

(1) There is a distinct evolution in form from a spherical, through various forms of ellipse, to the elongated conical egg-shell of the guillemot cited.

(2) In abnormal and embryonic eggs, normally non-spherical, there is often a reversion to the spherical form.

(3) Certain types of eggs characterise birds morphologically allied, addicted to the same mode of life, and subject to the same incident physical surroundings.

(4) Correlated with identity of form is unity of type in coloration, and it seems reasonable to suppose that this is due also to influence of surroundings—arising from which adaptations, protective resemblance, &c., may become necessary.

(5) When an egg retains permanently a form that it appears reasonable to regard as suited to environment, the same type of egg is not usually found to characterise other birds habituated to a different environment.

From (5) and the preceding premises, even though partly inferential, we may logically conclude that the form of eggs is connected with environment, for experiment, indeed, shows that all types of egg but that of the guillemot will roll off a table more readily than the latter, to instance one case alone; and it is generally admitted that the most potent factor in the production of modifications is the influence of environment. Furthermore, the egg-shell is not an indispensable product of reproduction, but has become necessary as a result of the acquired characters of different species of terrestrial organisms, so that we may regard this as further evidence of the influence of surroundings upon the bird and its egg; and thus variation in nesting-site, contributing to variation in form of egg, appears to follow by means of modifications arising from the causes indicated.

The determination of a force, in fact, is antecedent to its consequential mode of action. The latter is surely not an efficient cause, but an effect of an antecedent which we *may* call an efficient cause if we like. The one is subjective, the other objective, in nature, and these cannot be substituted. Function in an organ, or mode in which an organ performs its function, is not equivalent to cause. On this and the influence of surroundings reference may be made to the writings of Sir Ray Lankester ("Embryology and Classification," pp. 36–9), on the influence of memory and energy in evolution, Prof. Cope (*Amer. Nat.*, 1882, pp. 454–60), Ribot ("Heredity"), Hyatt ("Bioplastology," pp. 60–87), Herbert Spencer ("Principles of Biology").

Whether we regard the corpuscular or germ-plasm theory as the only tenable one, or whether we favour the dynamical theory, we can, I think, in either case allow that memory persists; and if it persists can it not recall in answer to stimulus a response given by the ancestor of a species? Cells may contain or retain by virtue of memory the characters of the species, but effort or energy is no doubt the means by which a response to stimuli, causing new characters to arise (and become fixed), may be conveyed. We may regard it as feasible that modifications are indirectly due to the influence of energy and memory on the germ-plasm, the specific type preserver, and that heredity or variation may be influenced in nature by the characters acquired by incidence of physical surroundings, whilst a response in an organism to outside stimuli creates a response from within, stimuli acting from within and without reacting upon one another. An organism being "a combination of rhythmically acting parts in moving equilibrium," it follows that "a change to a new state of equilibrium" will bring "the actions of all organs, reproductive included, into harmony with these actions," and the fact that "the units and the aggregate must act and react upon each other" (Herbert Spencer) more or less illustrates the view adopted. When the influence of memory and energy, and the reactions they give rise to, are duly appreciated, the recurrence during successive generations of identical characteristics is more readily understood, and the action of pangenesis becomes obscure if this excludes the perpetuation of all characters arising during the phylogeny of the group or the history of the individual.

The validity of the mode in which eggs assume different forms described by Prof. Thompson I freely admit, but in claiming it, as he does, as a cause of their variation I cannot agree with him, since mode of action follows determining cause, and, as Hyatt says, "The action of physical causes takes effect upon an irritable plastic organism which necessarily responds to external stimulant by an internal reaction or effort."

A. R. HORWOOD.

Leicester Corporation Museum, June 17.

## Lord Kelvin's Philosophy.

THERE is one word in Sir Oliver Lodge's interesting article, under the above heading, published in NATURE of July 2, to which I think some exception may reasonably be taken. In speaking of explanation in terms of force and action-at-a-distance, or in terms of motion and a continuous medium, Sir Oliver says that "To Lord Kelvin it would appear that both solutions were equally satisfactory, and that it was only a question of which was the most tractable." It is the word "equally" which is rather strong. He might indeed, as Sir Oliver says, prefer "to resort to the Boscovich doctrine"; but he would only do so in virtue of the tractability of the process, leaving aside for the time the question of the greater fundamentals. It was not at all a question of philosophy. It was a question only of the desirability of partial progress in place of no progress. His philosophy was Newtonian, postulating forces but reserving a medium.

In attempted explanation of certain elastic qualities in matter, he postulated a "simplest" Boscovichian system. That failing, he adopted a "second-simplest" system. Similarly, in attempted explanation of matter and energy, he postulated a simplest foundation in his vortex theory. That failing, he would doubtless have gladly framed a second-simplest foundation had he seen it to be possible. He was content to wait, meanwhile continuing his attack on the unknown along more presently promising lines.

In a letter of date December 1, 1905, referring to the molecular (Boscovichian) theory of magnetism and the "interesting truth" which it represents, he said "which will be added to when we know the physical quality of a molecular magnet and its relation to ether and to torrents of electrons through ether." In this spirit he was willing to wait for a knowledge of the physical quality underlying any other Boscovichian figuration.

W. PEDDIE.

University College, Dundee, July 8.

### The Magnetic Separation of Heavy Minerals in the Field.

For some time I have been trying to find a simple and rapid field method of separating the magnetic and faintly magnetic from the non-magnetic minerals in the residue obtained by panning a river sand or gravel. In the laboratory this is usually done by means of the electromagnet. I have experimented in the field with a portable electromagnet, but, apart from the disadvantages of weight, bulk, and clumsiness of manipulation, the dynamo is readily liable to go out of order and render the whole apparatus useless. My colleague, Mr. Longbottom, has experimented with a compound magnet composed of three or four simple horseshoe magnets bound together and fitted with adjustable poles. This gives admirable results, and is to be recommended for fractional separations, but the constant adjusting and re-adjusting of the poles becomes tedious in actual practice.

I find, however, that all the advantages of the electromagnet can be obtained in the field by the combined use of an ordinary large (8-inch) horseshoe magnet and a penknife. A small quantity of the residue to be examined is taken, and the magnetite removed in the usual way. The magnet is then held vertically over the sample, and the bright steel blade of a penknife laid flat across one of the poles with the back of the blade downwards. By gradually approximating the point of the blade to the other pole, and thus narrowing the space between the poles themselves, the power of the magnet is increased, and not only iron ores, but all the dark-coloured silicates and garnets can be rapidly and completely removed from the sample. The residue may then contain such valuable minerals as tinstone and monazite, which when in small quantity are frequently masked by the other minerals present. This method has the further advantage that any single grain can be rapidly tested by turning the point of the blade slightly down below the level of the poles and bringing it close to the grain in question.

As an invaluable field method, as a useful laboratory method where an electromagnet is not available, and as an actual working method for teachers of practical geology, I can recommend the one above described for simplicity, inexpensiveness, and trustworthiness.

J. D. Falconer.

Zaria, Northern Nigeria, May 24.

### The Sky Glows.

These phenomena on about June 30 and July 1, referred to in my letter (Nature, July 9, p. 221), I termed displays of Auroræ, and was prompted to apply that title by the descriptions given in some of the London newspapers, which stated that well-defined streamers had been observed from the metropolis.

But certain features of the glows struck me as being essentially different from exhibitions of normal Auroræ Boreales. No streamers whatever were seen here, but my view is somewhat restricted at low altitudes, and I thought they might have evaded recognition. The clouds observed were of peculiar character, and some of them showed traces of spiral formation. Though thin, they were strongly illuminative, and stars shone through them with surprising distinctness.

Here the display ranged over four nights, for on June 29 the sky was very light, and stars and Milky Way extremely faint, but clouds were very prevalent. On July 2 some attractive, coloured-cloud scenery was presented in the north-west and north, but the sky had not the bright, weird aspect it wore on preceding nights, and after midnight I saw nothing unusual.

Sounds proceeding from the north were strikingly audible in the still air, and I never remember to have heard the noise from distant railway trains in north-east so loudly before.

Whatever the true nature of the recent exhibition may have been, it is certain that something in the air exercised the capacity of reflection in a very high degree. The period was one of great heat and thunderstorms.

During past years, while engaged in meteoric or telescopic observation, I have occasionally noticed great differences in the transparency of the air. Occasionally the lightness of the firmament has struck me as being due to influences beyond local atmospheric causes. The variations have been great without palpable reasons, but no doubt there are different explanations applicable, though the observer finds it difficult to assign satisfactory ones in all cases.

W. F. Denning.

### A Remarkable Solar Halo.

On July 2, one of the days on which Miss Stevens saw a halo at Oxford (Nature, July 9, p. 221), a very bright halo was visible in the neighbourhood of Torbay. I first noticed it about 9 a.m., and it remained visible well into the afternoon. It attained its greatest brightness from 11 a.m. until noon. On looking at it through dark glasses it exhibited a somewhat remarkable form; the main halo had the usual radius of about 22°, but east and west were arcs of which the greatest distance from the sun was about 25°; these arcs gradually ran into the 22° halo. The effect was somewhat as though an elliptical halo were superposed on a circular one, the parts where the two coincided being of enhanced brightness. Below the sun there were at times fragments of halo at 44°. Masses of cirrus drifting from an easterly direction passed across the halo at times and partially obscured it, but probably had no part in its formation; it could be seen shining through the thinner parts of these clouds, and it regained its brightness as soon as they passed over. The halo was evidently formed by thin clouds above the ordinary cirrus, but no definite structure was visible to enable one to determine which way this layer was moving.

Charles J. P. Cave.

*Brunhilda*, R.Y.S., Fowey, July 12.

### Proposed Admission of Women to the Fellowship of the Chemical Society.

As president of the Chemical Society, I shall be glad if you will publish the accompanying letter referring to the correspondence as to the admission of women to the Fellowship of the Chemical Society which appeared in Nature of July 9.

W. Ramsay.

You have doubtless received a letter emanating from Oxford dated July 1 enclosing a circular and copy of the petition recently presented to the Council of the Chemical Society requesting the Council "to take such steps as may appear desirable to ascertain the wishes of the Society as a whole in regard to this question."

The envelope enclosing the above communications bore the familiar printed address-slips which might well lead Fellows to conclude that they were issued by authority of the Council. This is not the case.

The Council resolved that the statement of arguments on both sides which was issued to Fellows on June 23 was better calculated to elicit an unbiassed opinion of all Fellows if sent alone.

The course adopted by the signatories of the Oxford circular of July 1 is, therefore, not only unauthorised, but is in direct opposition to a resolution of the Council of which the signatories are members.

W. Ramsay (*President*).
Horace T. Brown (*Foreign Secretary*).
Alex. Scott (*Treasurer*).
M. O. Forster, Arthur W. Crossley (*Secretaries*).

### Linnæus's Authorities.

I should be very much obliged if any of your readers could supply me with the full titles of the works cited by Linnæus as follows in the twelfth edition (1766) of the "Systema Naturæ," p. 33:—

"Bont. jav. 84 *t.* 84; Koep. itin. *c.* 86; Dalin. Orat. 5."

I have looked up the works of Bontius in the British Museum, but they are not *ad hoc*. Also where, if anywhere, did D. Braad publish an account of his journeys to India?

Karl Pearson.

Biometric Laboratory, University College, London.

## THE MINES OF THE BRITISH EMPIRE.[1]

THE aim of Mr. Stokes's work on the mines of the Empire is to supply the non-technical reader with a description of the historical, physical, and industrial features of the principal centres of mineral production in the British Dominions beyond the seas. The bulk of the volume is based upon information collected during a tour of the Empire extending from January, 1906, to the beginning of 1908; and the author, who is an experienced technical journalist, has produced a book of conspicuous literary merit that cannot fail to prove of service as a work of reference. The illustrations, sixty-eight in number, are excellent reproductions of photographs, and have been carefully chosen to illustrate the importance of the mineral industry of the Empire.

The value of the annual mineral yield of the Empire now exceeds 200,708,000*l*. The quantity and value of the mineral products form a good barometer of industrial prosperity, and such statistics bear expressive testimony to the influence of the Empire as a factor in the mineral industry. Statistics for 1906 show that the Empire produced of the world's total yield the following percentages:—Gold, 60; silver, 12; tin, 73; copper, 9; lead, 15; iron, 18; nickel 60; manganese, 40; coal, 30; asbestos, 90; graphite, 45; mica, 90; and diamonds, 98. Similarly the influence of the mining industry upon the growth and welfare of the Empire is exhibited by the statistical history of the several colonial mineral territories. Thus the aggregate yield to the end of 1906 of Ballarat and Bendigo, Australia, discovered 1851, was 276,500,000*l*.; of the Witwatersrand, since 1885, was 162,000,000*l*.; of Kimberley, since 1869, was 85,000,000*l*.; of Broken Hill, New South Wales, since 1883, was 42,000,000*l*.; of Kalgoorlie, Australia, since 1893, was 37,000,000*l*.; of Mysore, India, since 1880, was 26,000,000*l*.; of Klondike, Canada, since 1896, was 24,500,000*l*.; of Charters Towers, Australia, since 1872, was 23,000,000*l*.; and of Mount Morgan, Australia, since 1882, was 13,000,000*l*.

Although the mines of the United Kingdom are excluded from the scope of the volume, the vast field covered will be evident from the following enumeration of the thirty-six chapters into which the work is divided:—Mine labour; mica and manganese in India; Burma rubies and petroleum; the Kolar goldfield; gems and graphite in Ceylon; industrial and geological conditions of the Malay States; Chinese and European mining methods in the Malay States; Bendigo and Ballarat, Victoria; gold and copper in Queensland; New South Wales mineral production; silver, lead, and zinc at Broken Hill, New South Wales; methods of extraction at Broken Hill; Mount Lyell copper mine, Tasmania; Mount Bischoff tin mine, Tasmania; gold, silver, and lead in Tasmania; north-eastern tinfields, Tasmania; growth of the gold industry of Western Australia; ore treatment at Kalgoorlie, Western Australia; Wallaroo and Moonta copper mines, South Australia; chief mineral localities of New Zealand; Waihi gold mine, New Zealand; mineral production of South Africa; Cape Colony, Orange River Colony, and Transvaal diamonds; mining in Rhodesia; Transvaal gold; Rand ore extraction and treatment; administration, labour, and working costs in the Transvaal; progress of the mineral industry of Canada; silver at Cobalt, Ontario; nickel at Sudbury, Canada; asbestos fields of Quebec; gold and copper at Rossland, British Columbia; Boundary copper district, British Columbia; Klondike alluvial gold; West Africa and the Sudan; and other British dependencies (British North Borneo, Labuan, and Sarawak, Fiji Islands, British New Guinea, Cyprus, Nigeria, British Central Africa, Uganda Protectorate, Newfoundland, British Honduras, Leeward Islands, Barbados, British Guiana, and Trinidad). From this enumeration it will be gathered that the chief mineral products of the Empire dealt with include gold, tin, copper, silver, lead, zinc, nickel, manganese, iron, antimony, bismuth, molybdenum, tungsten, coal, oil shale, petroleum, mica, graphite, asbestos, diamonds and other precious stones. So vast is the subject as a whole that congratulations are due to the author for the able and concise manner in which he has described the manifold characteristics of mineral occurrence and of methods of working in a form as lightly technical as is consistent with accuracy.

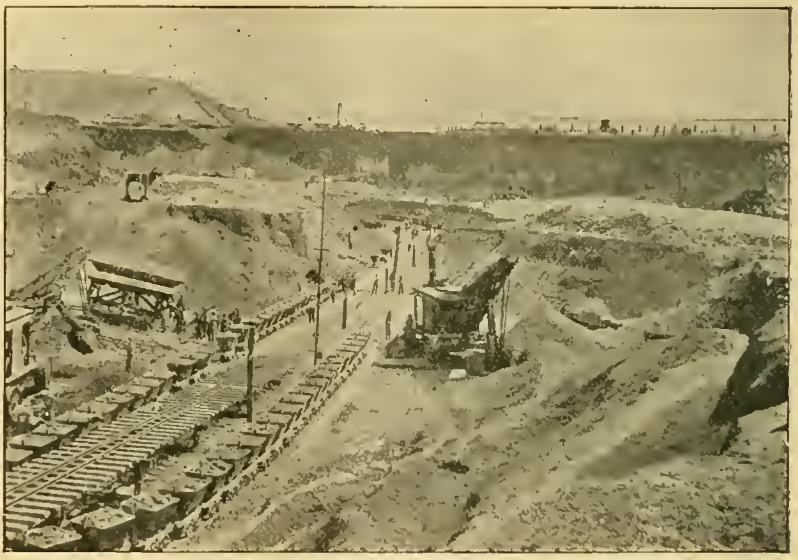


FIG. 1.—Premier (Transvaal) Mine in 1905. From "Mines and Minerals of the British Empire."

A perusal of the author's well-filled pages shows that the old established mining fields are constantly presenting fresh features, but that new discoveries attracting universal attention can be recorded but twice or thrice in a decade. Compared with preceding periods, and notably with the decade 1882–1891, which saw the discovery of the Witwatersrand, Mount Morgan, Sudbury, Waihi, and Broken Hill, the past ten years have not been marked by many new discoveries, the Premier diamond deposit in the Transvaal, which since 1902 has yielded 3,300,000*l*., and the silver veins of Cobalt, Ontario, which since 1903 have yielded 1,100,000*l*., having been the most brilliant discoveries. The Premier mine, which produced the diamond weighing 3025 carats now in the King's possession, is shown in the accompanying illustration (Fig. 1); and the character of the narrow rich veins, averaging 4 inches in width, at Cobalt is shown in

[1] "Mines and Minerals of the British Empire." By Ralph S. G. Stokes. Pp. xx+403. (London: Edward Arnold, 1908.) Price 15*s*. net.

Fig. 2. At surface, where the veins have been affected by atmospheric agencies, there is a high proportion of metallic silver. Much of the ore shipped in 1904 was largely composed of native silver. The discovery at Cobalt is an indication of Canada's bright prospects of becoming a more important mineral-producing country. In North America the territory controlled by Great Britain exceeds that of the United States. But of this immense area of 3,600,000 square

FIG. 2.—Metallic Outcrop of Silver Ore, Cobalt. From "Mines and Minerals of the British Empire."

miles only a very narrow fringe has even been explored, and yet the rocks of which a very large proportion of the unexplored area is in all probability composed are those which in the United States carry the most valuable mineral deposits. Here, and in other parts of the Empire, the world awaits the establishment of new mining regions to compensate for the steady impoverishment of the old.

## THE SECONDARY OSCILLATIONS OF OCEANIC TIDES.[1]

TIDAL observers have long known that at certain stations, mostly situated on bays or indentations of the coast, the simple curve of the tide-gauge is complicated by oscillations of level, often of considerable range and regularity of period. At first sight nothing could be further removed from the study of earthquakes than these irregularities of the tidal oscillation, but a connection has been discovered by the Japanese Earthquake Investigation Committee, whose diverse activity leads it to the study, not only of everything directly or indirectly connected with earthquakes, but also of everything which resembles their effect. The discovery, by Prof. Omori, that the periods of the earthquake-produced sea-waves were not uniform at neighbouring stations, but in each case agreed with those of the secondary oscillations of the tidal curve, naturally led to an investigation of this phenomenon, which has been noticed and made the subject of speculation by various observers. The investigation was carried out under the direction of Prof. H. Nagaoka, and has been published in a bulky and profusely illustrated quarto volume.

After a description of the improved and portable form of tide-gauge which was invented for the investigation, the ordinary limnograph being unsuitable and the ordinary tide-gauge too cumbrous, we have a detailed account, illustrated by reproductions of the tide curves and charts, of the records from fifty-one stations on the Japanese coasts. A general summary of the results is given, from which it appears that on the open Pacific coast, or in a bay of considerable area communicating with the sea by a narrow outlet, the tide curve is of a simple character, the secondary oscillations being small and irregular; but in more open bays, the breadth of which is not too large in comparison with their length, secondary oscillations are conspicuous, and often show great regularity of period. Simultaneous observations at different places along the shore-line showed that the phase of oscillation was usually the same throughout the bay, and that the oscillations which were conspicuous within the bay could be detected, with the same phase, but much reduced amplitude, at its mouth. From this it appeared that the whole mass of water in the bay was in simultaneous oscillation in a stationary wave, analogous to the sound-wave in an open organ pipe, and that the bay selected from the multitudinous ocean waves of various period the particular one to which it was able to respond, and, like a resonator with sound-waves, magnified and made it conspicuous.

This conclusion was verified by experimental investigation. Models, to scale, of the bays were made and sunk to the appropriate level in a large tank of water; in this tank was immersed a leaden ball which, being attached to a simple or a horizontal pendulum, could be set in oscillation with any desired period, and by its movement communicate to the water in the tank a periodic oscillation, unaccompanied by any appreciable surface-wave; reflection from the walls of the tank being checked by a thick layer of damping material—wood-shavings, to wit. By exciting waves with this arrangement the water in the model of the bay was put into standing oscillation, the amplitude of which was generally small; as the period of the pendulum approached the proper period of the bay, the amplitude of oscillation gradually increased, and, when the period exactly coincided with that of the model, the amplitude reached its maximum, continuing, with a regular period, after the pendulum was stopped. The phase of the water particles was the same for all parts of the bay when the oscillation was a fundamental one, but a binodal or trinodal oscillation was easily produced in an elongated bay.

An ingenious development of the experiment consisted in sprinkling aluminium powder on the surface of the water and photographing the model with a camera suspended vertically above it; by giving an appropriate length of exposure, the movement of the particles reproduced the course of the stream-lines on the resulting photograph. In Fig. 1 we reproduce one of these photographs, showing the motion where the induced wave is the fundamental oscillation, in which the mouth of the bay is a node for

[1] "An Investigation on the Secondary Undulations of Oceanic Tides, carried out by the Order of the Earthquake Investigation Committee during 1903-6." By Drs. K. Honda, T. Terada, Y. Yoshida and D. Isitani. Preface by Prof. H. Nagaoka. Pp. viii+113; 95 plates, 2 frontispieces. Published as No. 26 of Publications of the Earthquake Investigation Committee in Foreign Languages, and as vol. xxiv. of the Journal of the College of Science, Imperial University of Tokyo. (Tokyo, 1908.)

vertical and a loop for horizontal motion, while the head is a loop for vertical and a node for horizontal

FIG. 1.—Model of Aomori Bay, showing stream lines of fundamental oscillation: period 4·453 in model, representing 303 m. in the bay itself.

motion. The period of this oscillation in the model was 4·45 seconds; the factor, corresponding to the scale adopted, being 4090, this represents a period of

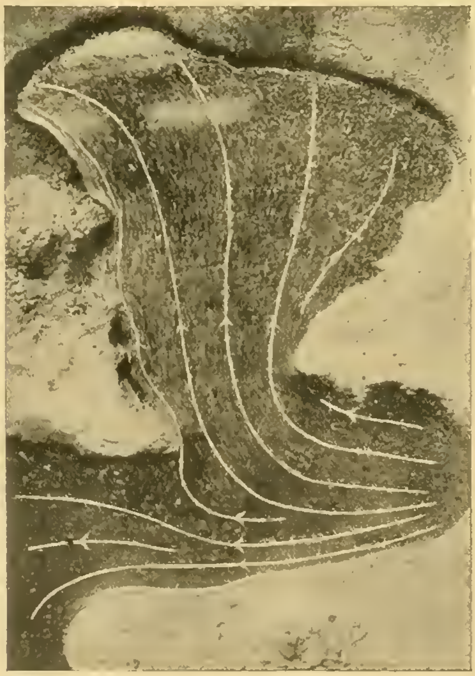


FIG. 2.—Model of Aomori Bay, showing stream lines of lateral oscillation: period 1·63 in model, representing 108 m. in the bay itself.

303 m. in the actual bay, in which a periodic oscillation of 300 m. was observed. Besides this fundamental wave, the water within the bay could be set into lateral oscillation, as shown in Fig. 2, with a period of 1·60 s. in the model, representing 108 m. in the actual bay, where a well-marked regular undulation of 103 m. was observed.

The account of the experiments is followed by a mathematical treatment of the subject, and a calculation of the periods of the stationary waves for each of the bays investigated, a calculation which gave results in general, and sometimes in close, accordance with the observed periods. Finally, there is a suggestion that the great increase in the range of tides near the head of large bays may be partly due to this cause. The Bay of Fundy is celebrated for the great range of the tide near its head, where the difference between high and low water is from 50 to 70 feet, while near the mouth the range is not more than 7 to 10 feet; the difference is partly attributable to the banking of the tidal wave as it travels up a narrowing channel, but, the fundamental period of oscillation of the bay being about twelve hours, it is by no means improbable that this has a material effect in increasing the range of the semi-diurnal tide, with which it approximately agrees in period.

We have indicated sufficiently the scope of this important memoir, the unseismological interest of which has been recognised by its simultaneous appearance as one of the publications of the Earthquake Investigation Committee and as a volume of the Journal of the College of Science of Tokyo.

## VESTIGES OF SCALES IN THE FOX.

IN the case of such a familiar animal as the fox it might well have been supposed that everything worth knowing in the matter of its bodily structure had already been recorded. That this is not so is demonstrated in an article by Mr. K. Toldt, of Vienna, published in the April number of the *Zoologischer Anzeiger*, where it is shown, on what appears to be practically conclusive evidence, that the fox is descended from ancestors the bodies of which appear to have been clothed with horny scales like those of the pangolins, or scaly ant-eaters. Although these scaly ant-eaters are the only living mammals the bodies of which are completely covered with overlapping scales, armadillos furnish us with an example of another type of armour in the same class; while there are several groups of mammals in which some portion of the body is scaly. In the rat, for example, the whole tail is scaled, and more or less distinctly scaled areas are met with in several porcupines and certain other rodents, as well as on the tail of the great South American anteater. In all cases where hairs grow from the body between the scales (as they almost invariably do), such hairs, in place of being scattered about in an irregular manner, have a certain definite arrangement. They grow, for instance, in isolated bundles, arranged in some cases in groups of three or four, and placed at regular intervals from one another.

From the fact that the hairs are arranged in this peculiar and definite fashion in a number of species which show no traces of scales, it has been suggested that such mammals trace their descent from scale-clad ancestors.

Careful examination of the skins of young foxes has enabled Mr. Toldt to announce, not only that the hairs are arranged in this peculiar fashion, namely, in groups of three bundles, each containing some fourteen or fifteen hairs, but likewise that the skin itself actually exhibits a structure such as would be presented by that of a pangolin after the scales had been pulled out. Viewed through a microscope, the skin presents, in fact, the appearance of a roof covered with overlapping rounded tiles, with the triply-arranged bundles of hair growing between each "tile." Moreover, when seen in cross-section, the skin is observed to be thrown into a series of ridges or steps, each of which represents the free edge of one of the "tiles." To explain such a structure otherwise than as representing the bed of a scaly armour seems impossible, or at all events illogical, and we are accordingly compelled to accept the author's view that the fox is descended from scale-clad ancestors. No actual traces of scales have been observed in any of the skins yet examined, but Dr. Toldt suggests that such might be detected if a large series of skins of young fox-cubs were examined under proper conditions.

Although no mention of this point is made by the author of the paper referred to, the fox is just one of those animals which might naturally be expected to retain traces of its descent from reptilian ancestors. There is good reason to believe that the extinct mammal-like reptiles of South Africa were the immediate forerunners of the primitive carnivora or creodonts of the Tertiary period; while it is certain that from these latter are descended the modern carnivora, among which the fox, in common with the other members of the dog tribe, is one of the most primitive and least specialised representatives.

## NOTES.

A STATUE to Bunsen, raised by public subscription, will be unveiled at Heidelberg on August 1.

WE regret to see the announcement of the death of Lord Blythswood, F.R.S., at seventy-one years of age.

SIR WILLIAM H. WHITE, K.C.B., F.R.S., has been elected chairman of the council of the Royal Society of Arts for the ensuing year.

PROF. GEORGE HALE, director of the Mount Wilson Observatory, California, has been elected a foreign correspondant in the astronomical section of the Paris Academy of Sciences in succession to the late Prof. Asaph Hall.

DR. BOUCHARD has been elected president of the Paris Academy of Sciences in succession to M. H. Becquerel, who was recently appointed permanent secretary of the academy. Prof. Émile Picard succeeds Dr. Bouchard as vice-president.

THE congress of meteorologists representative of the United Kingdom and of the British colonies and dependencies, which it was proposed to hold in Quebec in the last week of this month, has been postponed until next year.

THE well-known expert on turbines and hydraulic engineering, Prof. A. Stodola, of the Zürich Polytechnic College, has been awarded the Grashof gold medal of the Society of German Engineers.

THE council of the Society of Engineers and the council of the Civil and Mechanical Engineers' Society have approved a scheme of amalgamation which is expected to meet with the cordial support of the members of both bodies. This is a welcome innovation in the policy of technical societies, as of late years there has been a growing tendency to form new societies, and the consequent overlapping of work has rendered bibliographical research increasingly difficult.

A THOROUGHLY representative exhibition of mining machinery was opened at Olympia by Lord Strathcona on July 11. An interesting popular feature of the exhibition, which will remain open until July 31, is a series of realistic scenes giving an excellent idea of the practical working side of the Empire's mining industries. These scenes represent prospecting for diamonds in South Africa, gold mining in the Transvaal, alluvial gold mining in the Klondyke, hydraulic gold mining in New Zealand, tin mining, coal mining, granite quarrying, and Bath-stone mining.

IN the House of Commons on July 8, Mr. Dundas White asked the Prime Minister whether the Government would give facilities for the passing this session of the Daylight Saving Bill, now entitled the Local Time (Great Britain and Ireland) Bill; and, if so, whether the Government would propose amendments making clear that the adoption of the proposed modification of time was not compulsory, and substituting for the term local time some less ambiguous term. In reply, Mr. Asquith said:—"The Government have no intention of giving facilities for the passing of the Daylight Saving Bill."

IN the Chancery Division of the High Court, Mr. Justice Eve has just decided that china clay is a mineral within the meaning of the Railway Clauses Consolidation Act, 1845. The right to work china clay in some land purchased by the Great Western Railway Co. was claimed by the vendor to the company and owner of the adjoining land. Notice of this claim was given to the railway company, which brought the action for an injunction to restrain the owner from excavating the land near and under their line in Cornwall to get china clay, on the ground that the product obtained was not a mineral in the sense of the Act of 1845. Mr. Justice Eve, however, decided against this view, and gave judgment for the defendents. A full report of the judgment appears in Wednesday's *Times*.

WITH a view to obtain accurate information regarding the nature and extent of the damage done by rats in the United Kingdom, the committee of the Society for the Destruction of Vermin has prepared a schedule of questions for wide distribution. It is desired to obtain information from all persons who are in a position from their own experience to give particulars concerning temporary or permanent rat plagues, the damage done by rats, the steps taken to prevent such damage, and the results obtained. The secretary of the society, Mr. A. E. Moore, 95 Wigmore Street, London, W., will be glad to send a copy of the schedule of questions to any person who is able and willing to send information.

THE Paris correspondent of the *Times* announces that M. Henri Deutsch de la Meurthe has offered a new prize of 1000*l*. for the first aërial automobile apparatus, either lighter or heavier than air, which will transport Commandant Renard to England. If he is conveyed by an automobile balloon, the descent must be made at Aldershot Camp. If he goes on an aëroplane, however, it will only be necessary to reach the English coast. From the same source we learn that Commandant Renard, in some comments on the recent exploits of Mr. Henry Farman at Issy les Moulineaux and of M. Delagrange in Rome, referred to the fact that both aëronauts have remained more than fifteen minutes in the air, and remarked, "In less than two years the distance traversed by an aëroplane has passed from twenty-five mètres—the famous preliminary bound of M. Santos Dumont in October, 1906—to nearly twenty kilomètres, a proportion of 1 to 800." At that rate, within two years it will be possible to make journeys of twenty days without stopping. At all events, there is nothing extraordinary, says Commandant Renard, in thinking that journeys of several hours, and even of an entire day, will soon become quite normal.

The *Comptes rendus* of the Paris Academy of Sciences for June 29 contains the report of the committee appointed to consider the distribution of the Bonaparte fund for 1908. The committee has considered 107 applications for assistance from this research fund. Some of these, it is mentioned, do not comply with the conditions laid down by the founder, Prince Roland Bonaparte, and others are for work entirely outside the field of the Academy of Sciences. The committee excludes also demands for assistance in researches in medicine, surgery, and general biology, since the funds of the *Caisse des Recherches scientifiques* are exclusively reserved for biological studies. Ten grants are recommended as follows:—(1) 2000 francs to L. Blaringhem for a continuation of his important studies on the variation of species and the experimental methods for the creation of new species of plants; (2) 2000 francs to Dr. Billard to enable him to pursue his studies on the hydroïds; (3) 2000 francs to Dr. Estanave to furnish him with the means of continuing his researches on direct vision projection in relief, with special reference to radiography; (4) 2500 francs to MM. Fabry and Buisson for a continuation of their work on the establishment of a system of standard wave-lengths. The grant is to be applied to the purchase of a plane grating, a metal concave mirror of large diameter, and two plane mirrors required for a study of the differences between the lines of the solar spectrum and those of the electric arc; (5) 5000 francs to M. Gonnessiat for the purchase of astronomical instruments for the observatory of Algiers; (6) 2000 francs to Dr. Loisel for the continuation of his actinometric observations at the Observatory of Juvisy; (7) 2000 francs to M. Dongier for the establishment of apparatus for the simultaneous study of the rainfall and atmospheric potential; (8) 2500 francs to M. Perot for the spectroscopic study of the light from the sun by interferential methods; (9) 2000 francs to M. Matignon for the determination of specific heats at high temperatures; (10) 3000 francs to P. Colin for the publication of a map of South Imerina. These recommendations were adopted by the academy.

The "Brisbane beds" of Queensland, at one time supposed to be of Jurassic age, form the subject of an article by Mr. S. B. J. Skertchly in the first number of a new serial, the *Queensland Naturalist*. Their plant-remains prove them to be of early Tertiary age—perhaps equivalent in time to the Laramie beds of the United States.

Among other American papers, we have to acknowledge the receipt of one by Mr. C. S. Townsend on the taxonomy of the more typical flies, with descriptions of new genera and species, forming part of vol. li. of Smithsonian Miscellaneous Contributions; also one by Alice Robinson, issued as No. 5 of vol. iv. of the Zoological Publications of California, on the incrusting chilostomatous bryozoans of the Pacific coast of North America.

In an article communicated to the current volume of the Journal of the Asiatic Society of Bengal, Mr. R. B. Sanyal urges the importance of establishing an aquarium for scientific research in Bengal. The author quotes Lieut.-Colonel Alcock to the effect that the ideal situation for such an establishment would be the Orissa coast, in the immediate neighbourhood of the sanatorium at Puri. With some modification of the salt-excise, it is believed that a fishing and dredging station on this coast would yield a large revenue from dried fish, fish-oil, isinglass, &c., while from the scientific point of view such an establishment would almost certainly result in discoveries of profound interest and importance.

We have to acknowledge the receipt of four parts (vol. xxiii., Nos. 5–8) of the Journal of the College of Science, Imperial University of Tokyo. No. 5 is devoted to the appendicularians (such as Kowalevskia, Fritillaria, and Oikopleura) met with in Japanese waters in the Noctiluca-plankton, the author, Mr. T. Aida, giving elaborate details of their anatomy. New cicadas from Europe and the Mediterranean region generally are described by Dr. S. Matsumura in No. 6, while in No. 7 Mr. S. Tanaka gives descriptions of fourteen Japanese fishes regarded as new. Finally, in No. 8, Mr. I. Ikeda gives full details of the structure of three remarkable forms of Japanese echiurid gephyrean worms of which preliminary descriptions have appeared elsewhere. The paper is illustrated by four plates, of which the first is coloured.

The first article, comprising 360 pages, of vol. viii. of the Bulletin of the Illinois State Laboratory is devoted to the organisms and their seasonal distribution of the plankton of the Illinois River, based on the results of observations and collections made from 1894–9. The plankton of fresh waters, observes the author, Dr. C. A. Kofoid, differs from that of the sea in the almost universal absence of larval forms of life, in the smaller number of invertebrate groups represented, and in the smaller size of the species. Notwithstanding this lack of the larger forms, the Illinois plankton represents a larger quantitative amount of organic matter per cubic metre of water than is the case with marine plankton. The relative abundance of diatoms, of green and blue-green algas, and of chlorophyll-bearing flagellates, apparently affords abundant sustenance for the animal section of the plankton.

It has long been a puzzle how the "oystercatcher" opens the shells of the mussels which form its main diet. The question has been set at rest by an article contributed by Mr. J. M. Dewar to the June number of the *Zoologist*. The great majority of the molluscs are opened from the dorsal border, when the valves are gaping, by the bird thrusting its beak into the aperture and then using it as a lever, at the same time severing the adductor muscles. If one of the valves be fractured in the process, the lever-action becomes unnecessary. About 9 per cent. of the mussels are opened on the ventral border, where the aperture for the byssus renders them as vulnerable when the valves are closed as when open. Mussels presenting this aspect are carefully searched for by the birds. Finally, about 13 per cent. of the mussels are attacked at the posterior extremity of the shell.

In a special report issued by the Government of Egypt, Captain Stanley Flower has published an account of his round of visits to the menageries, aquariums, and museums of Europe in 1907 for the purpose of acquiring information which might prove advantageous to the establishment under his care at Giza. Much of the interest of the report is centred on the notices of local and private collections of which the general public knows but little. Among the latter, special reference may be made to the wonderful collection of living fresh-water fishes maintained by Captain J. A. M. Vipan in two special buildings in the garden at Stiblington Hall, near Peterborough. Among the rarities in this collection may be mentioned specimens of the bichir (Polypterus) from the Gambia, and Russian sterlets presented by H.I.M. the Czar of Russia. Mr. F. E. Blaauw's collection of mammals and birds at Gooliust, near Hilversham, also comes in for commendation. The report concludes with a list of the antelopes seen by the author in the course of his tour and one of those now living in the Giza Gardens. Captain Flower, we notice, uses the name *Portax picta* for the nilgai and *Oreas canna* for the eland, thereby demonstrating that modern emendations in nomenclature are still by no means universally accepted.

WE have also received a copy of the report of the Giza Zoological Gardens for 1907, illustrated with a coloured plan. The year appears to have been an unusually successful one, the number of visitors and the amount of money taken at the gates being in excess of any previous season. Captain Flower directs special attention to the circumstance that both kudu and addax have bred in the menagerie.

A FLORA of the Austrian Duchy of Styria, "Flora von Steiermark," prepared by Dr. A. von Hayek, is announced by the publishing firm of Gebrüder Borntraeger. To the special section consisting of an enumeration of the plants will be added a general survey of plant distribution in the duchy and in neighbouring countries. The work is to appear in about eighteen monthly parts, each costing three marks. The first part contains the pteridophytes and a few pages of the gymnosperms. The features of the work are the analytical keys to the orders, genera and species, brief diagnoses and localities for each genus and species, and references to literature. Considerable interest attaches to the flora, as certain ranges of the eastern Alps lie within the province, and the vegetation in the lowlands shows affinities with the flora of Illyria.

A SHORT account—accompanied by excellent illustrations —of the anatomical features of the extranuptial nectaries of certain plants is contributed by Mr. K. Ono to the Journal of the Royal College of Science, Tokyo (vol. xxiii., article 3). On the ground of development, the writer distinguishes two types of nectaries, those derived from epidermal cells only, as in species of Polygonum, and those derived from both hypodermal and epidermal cells. It is stated that in some cases the secretion from the glandular cells is forced into a space between them and the cuticle, until finally the liquid escapes by rupture of the cuticle; in other cases it is believed that the secretion permeates the cuticle. Physiological experiments indicated that the secretion is mainly controlled by internal conditions, and that of external factors moisture is the most important.

THE idea has been mooted, and has met with some measure of acceptance, that as agricultural land after a repetition of crops of any given species becomes unsuited to the requirements of that species, so, after a proportionately long period, on land bearing pure forest, the seedlings of the crop may eventually fail owing to changes in the properties of the soil. In this connection, Mr. B. O. Coventry contributes an article on alternation of forest crops to the June number of the *Indian Forester*. He instances the observed failure of natural reproduction of the blue pine, *Pinus excelsa*, under its own cover with the incursion of deodar, also the gradual extension of mulberry into a Punjab plantation where originally "shisham," *Dalbergia sissoo*, was dominant. In the North-West Provinces, at a high level, it has been noted that *Quercus incana* is invading the domain of *Pinus longifolia*, and blue pine is advancing into the oak; at another level, *Quercus semicarpifolia* is losing ground to spruce and silver fir. The subject is one that deserves the attention of foresters.

THE attention of geologists may be profitably directed to two important papers on the submarine stratigraphy of the English Channel, published in the Journal of the Marine Biological Association of the United Kingdom, vol. viii., No. 2, in May of the present year. Mr. L. R. Crawshay (p. 99) discusses the conditions under which the stones and gravel on the Channel floor become exposed by a constant drift of the fine material towards the English coast. Mr. R. Hansford Worth contributes (pp. 118–188) a critical review of a large number of specimens dredged up by Mr. Crawshay on the S.S. *Oithona* in 1906, and also describes those collected by previous observers, including his own published work of 1899. The greatest interest centres in the discovery of true chalk, in addition to numerous flints, in the region south of the Eddystone. Flints occur, indeed, in practically all the dredgings. One block of foraminiferal limestone, with Miliolinas, clearly of Eocene age, was found in mid-channel off the Lizard, providing a valuable argument for those who view the Parisian *Calcaire grossier* as having been deposited in a sea spreading eastward from the Atlantic. Mr. Worth brings his conclusions together in the form of an interesting geological history of the depression which resulted in the English Channel.

IN *Meteorologische Zeitschrift* for May, Dr. J. Hann contributed an interesting paper on the problem of the vertical distribution of sea temperature in the eastern Mediterranean. He asks what conceivable physical process would allow the surface temperature to penetrate to a depth of about 500 metres, as has sometimes been assumed, in the period of half a year; the chief object of the paper is to raise a discussion on this question. Dr. Hann thinks that the lower limit of vertical circulation might be assumed to be about 100 metres, and that we should then have to distinguish between three different strata of temperature:—(1) the superficial, to a depth of about 100 metres; (2) from about 500 metres to the bottom, where the temperature is nearly uniform (14° C. to 13°·5 C.); and (3) the intervening space from, say, 100 to 500 metres.

WE have received vol. xlix., part ii., of the Annals of Harvard College Observatory, containing meteorological observations at eight auxiliary stations in Peru for the years 1892–5 from records of self-registering instruments. Although these records are not complete, especially at the mountain stations, where the difficulties of carrying on observations at such great altitudes are considerable, meteorologists are much indebted to the authorities of the college for this valuable contribution, which has been very carefully prepared for publication by Prof. Bailey under the direction of Prof. Pickering. In general, only the hourly means and extreme values for each month are given, but for the mountain stations individual readings are published. The observations at Arequipa for the same period were contained in part i. (to which we have already referred), and the eye observations, with descriptions of the stations and an account of the difficulties connected with them, were given in vol. xxxix., parts i. and ii.

STATISTICS issued by the Home Office show that the total production of coal in the United Kingdom last year was 267,830,962 tons, which is an increase of 16,763,334 tons over that of the previous year. The death-rate from accidents of underground and surface workers as a whole was 1·32 per 1000.

THE Marine Department of the Board of Trade has issued a circular (No. 1443) dealing with the manufacture and testing of steel. The instructions given are based on the reports of the Engineering Standards Committee, and deal with the testing of steel for use in boilers, plates, angle, rivet and stay bars, steel forgings, and steel castings.

In the *Engineering Magazine* (vol. xxxv., No. 3) Mr. H. T. Wade gives an illustrated description of an interesting exhibition, designed to show the best methods of safeguarding workmen and of protecting the general public, which was recently held in New York by the American Museum of Safety Devices and Industrial Hygiene. The exhibition was of great importance in showing that much of the loss of life in industrial operations in the United States is preventable, and that there are already developed methods and appliances that accomplish much in this direction.

The Zoelly turbine is the youngest of the steam-turbines which have risen to any degree of commercial importance, and in view of the fact that it entered a field already occupied by powerful interests and well-established rivals, its progress has been remarkable. Designed by M. Heinrich Zoelly, of Zurich, it was first put on the market in 1904, and has since then been most energetically developed, particularly on the continent of Europe. It is of the compound impulse type, that is, the steam is expanded successively through small ranges of pressure, the velocity acquired during each expansion being utilised by a separate single wheel. Each wheel runs in a compartment by itself, the number of wheels required being determined by the range of expansion through which the turbine has to work, the pressure in each compartment being never less than 58 per cent. of that in the previous one. This limitation enables the full expansion at every stage to be obtained with simple convergent nozzles, which are easier to design and more efficient than the flared nozzles, which become necessary with greater expansion ratios. An exhaustive description of this turbine is given in *Engineering* of July 3, with dimensioned drawings and reproductions of photographs of the 210 horse-power Zoelly turbine direct-coupled to a centrifugal pump shown by Messrs. Mather and Platt at the Franco-British Exhibition.

Messrs. Negretti and Zambra have submitted to us for examination their new prismatic binocular, the "Minim," which they have recently issued. The distinguishing features of the new glass are its compactness, lightness, and small bulk. Its weight is only 10 oz., and it is as small as any other prismatic binocular of the same power, the height being only $3\frac{3}{8}$ inches. These points, however, have evidently been attained without any sacrifice of the essential rigidity of an instrument of such high power. The makers state in their specification that, in order to secure this compactness, lightness, and small bulk, in conjunction with so powerful a magnification as eight diameters, it is of course necessary that the lenses and prisms must be small, and that in consequence the light-transmitting power will, under certain conditions, be smaller than with glasses having large lenses. These conditions, however, are not likely to occur often enough to compensate for a conveniently portable instrument, and on an average day the "Minim" gives ample illumination. The size and shape are such that the binocular can be easily kept in the pocket, and for this purpose it can be supplied in a soft leather case instead of the usual stiff leather sling-case. It is constructed with a well-designed rack focus adjustment on the differential screw principle, giving very easy motion which can be operated by one finger, and which has the additional advantage of not wearing slack with continued use. One eye-lens is separately adjustable for the correction of anisometropia, and both tubes are on the usual swing pivot for adjustment of pupillary distance. The power of eight diameters magnification has been chosen after careful consideration as being the best for ordinary requirements, such as touring and every kind of sport; at the same time, it is not too high for marine work, and is about the limit for holding steady without any subsidiary support. We have also found it extremely useful for many objects in astronomy; for instance, the views of the half-moon on a clear night are magnificent. The general performance of the glass satisfies all of a series of tests on various objects which we have tried. The optical definition is very fine, a pleasing feature being the instantaneous change on either side of the best focus. The images are pleasingly achromatic. We would urge on users of all prismatic binoculars or high-power telescopes that to get critical definition it is necessary to re-focus whenever the distance of the object being viewed is changed, as these instruments have not the latitude in depth of field to which we are accustomed in the ordinary opera-glass of low power.

The last number of the Proceedings of the Royal Society of Edinburgh (vol. xxviii., part iv.) includes a paper of forty-three pages on the problem of a spherical gaseous nebula, continuing and completing Lord Kelvin's work upon this subject. In his last paper, a contribution to Nature of February 14, 1907, Lord Kelvin directed attention to what he called the curious "Perry theorem," which ought to be called the Ritter theorem, namely, that a spherical mass of gas of which the specific heat ratio is less than $1\frac{1}{3}$ must be unstable. What makes a paper of this kind particularly interesting is that Lord Kelvin never satisfied himself with a mere mathematical statement of such a theorem as this; he always sought out the physical meaning of it. It may be said that the paper gives a complete statement of the development of the past work of Lord Kelvin himself, also of Homer Lane, and of Ritter and Perry. It was left incomplete by the author, and it has been well edited by his secretary, Mr. George Green, who has given much time to the calculation of many useful tables of figures.

Messrs. Aston and Mander submit for examination a specimen of the "Compton" slide-rule, which they are selling at nine shillings. As is now universal, the divided surfaces are on white celluloid, and a glass cursor with one cross-line is provided. The radius of the A and D lines are 125 and 250 millimetres respectively, as is usual with rules about 10 inches long. The sine and tangent lines at the back of the slide are graduated from the same end, and in order to be able to read both sines and tangents, or to execute proportions in which one or other come in as factors, without shifting the slide, the slide when reversed is the right way end for end for both at the same time. Of course, as the tangents with this arrangement are read against the D line, they are on twice the scale, and may be read with twice the accuracy. The wood is mahogany, and two celluloid strips are used to face the thin portion of the rule. The two edges are divided, and the inside has the linear divisions continued after the manner of a hat measure. The divisions are fine and accurate, and the working easy and smooth.

The three articles on the work done at the Physikalisch-Technische Reichsanstalt at Charlottenberg during the year 1907, which appeared in the April, May, and June numbers of the *Zeitschrift für Instrumentenkunde*, have now been issued separately, and form very interesting reading. Sufficient information is given to allow the reader to understand the work done and the methods used, and in many cases in which apparatus of a novel kind has been used a figure of it is given. It is scarcely necessary to say that the work is of the highest order, and affords ample evidence of the close association of the institution with the manufacturers of Germany. The idea of publishing in the technical Press an account of work done is a good one, and might well be followed by similar institutions with which manufacturers have not yet learnt to cooperate as much as they might.

THE *Physikalische Zeitschrift* for July 1 contains an account of some observations made by Dr. S. Landau, of Göttingen, on the magnetic rotation of the plane of polarisation in rock salt, Iceland spar, water, and alcohol, with the view of testing the theories which have been advanced in explanation of the phenomenon. His method is a photographic one, the light from an iron arc passing through a polarising prism, the magnetic field, a half-shadow prism, and a spectrograph in succession, the slit of the latter instrument being at right angles to the dividing line of the half-shadow field. Several photographs are taken on the same plate, the polarising prism being rotated through a small angle between each, and from inspection of these the position of the prism for equal intensity of the two halves of a line in any part of the spectrum is found. The author concludes that the electron theory is capable of reproducing all his observations, but that some of the constants which, if only negative electrons are assumed to play a part in the phenomenon, should come out positive, have negative values, and suggest, therefore, that the positive electrons play a part. Against this, however, many objections may be raised.

IN the note upon the seventh International Congress of Applied Chemistry in last week's NATURE (p. 229), it should have been stated that Sir William Ramsay, K.C.B., F.R.S., will be the acting president of the congress, and Sir Henry Roscoe the honorary president. We are informed that Prof. Nasini will not give one of the lectures to the congress, but a lecture will be given by Prof. Paterno, of Rome.

IN the issue of NATURE for June 2, 1904 (vol. lxx., p. 107), an optical illusion observed by Dr. T. Terada, of the College of Science, Tokyo, was described. Dr. Terada directs attention to another illusion he has remarked. After watching drops falling at the rate of about one a second into the centre of a small pool, and so causing circular ripples, he turned his eyes to a spot on a neighbouring bush. The bush appeared to contract slowly towards the point looked at, but the contracting motion was slower than the diverging motion of the ripples. A similar effect was noticed by looking at the ground or at a wall.

## OUR ASTRONOMICAL COLUMN.

SATURN'S RINGS.—The June number of the *Astrophysical Journal* (vol. xxvii., No. 5, p. 363) contains a note by Prof. Wright in which he discusses the bright beads, or knots, which were observed during the recent opposition when the unilluminated surfaces of the rings were turned earthwards. Criticising Prof. Barnard's recent explanation, in which the author supposed the brightness of the beads to be due to light percolating by many reflections through the masses of meteorites composing the rings, he points out that whilst this is probably true for the crape ring, it seems impossible that sufficient light to produce the outer bright knots could pass between the more densely packed meteorites of the outer rings. Then turning to Bond's explanation of the phenomena, Prof. Wright shows that it accounts for the bright outer knots and for the very slight asymmetry which is suggested by comparing the measures of different observers. He further suggests that it is not unlikely that collisions among the meteorites may account for some, at least, of the observed luminosity over the surfaces of the two dense rings and in the knots.

NEW PHOTOGRAPHIC CELESTIAL CHARTS.—On a supplementary sheet to No. 4257 of the *Astronomische Nachrichten*, Prof. Johann Palisa invites subscriptions to a series of photographic star charts prepared by Prof. Max Wolf at Heidelberg. Having received copies of his maps privately from Prof. Wolf, Prof. Palisa found that his work of finding minor planets was reduced by 75 per cent., so he suggested that the sheets should be published, as they will undoubtedly prove very useful in other branches of astronomy. The sheets will be printed on smooth matte bromide paper with a degree *reseau*, and each sheet will include some fifty square degrees, the scale being such that $1^\circ = 36$ mm. This enterprise is purely a private one, of which the cost must be borne by the subscribers, so that Prof. Palisa invites all who wish to subscribe to apply to him as soon as possible, and before December 31 at the latest; the price of the series containing twenty sheets is thirty shillings, and after the date named must be forty shillings. The maps reproduce stars down to about the fourteenth magnitude.

DOUBLE STARS.—An example of the good work that may be done by an amateur astronomer with but a moderate-sized instrument appears in No. 4259 of the *Astronomische Nachrichten*, where a list of double stars discovered and observed by Mr. E. D. Roe, jun., of Syracuse, N.Y. (U.S.A.), with a $6\frac{1}{2}$-inch Clark refractor, is published. His observatory was erected in July, 1906, and by the end of 1907 he had independently discovered some 250 double stars (generally separated by less than 10″), of which he has since identified a number with doubles given by Prof. Burnham. The present list contains the measures of the stars thus identified.

In the same journal Herr J. Fr. Schroeter publishes a list of corrections to Prof. Burnham's "General Catalogue" for double stars included in the Christiania zone.

No. 4260 of the *Astronomische Nachrichten* (p. 185, July 3) contains a discussion by Herr E. Schoenberg, of Dorpat, of the orbits of several double stars, including $\beta$ 581, $\beta$ 883, S Sextantis = AC.5, and $\beta$ 612.

THE ALBEDOES OF JUPITER'S FIRST AND THIRD SATELLITES.—In the July number of the *Bulletin de la Société astronomique de France*, M. Quénisset records some observations made in January and March showing the relatively low albedoes of the surfaces of Jupiter's first and third satellites. The disc of Ganymede when seen outside the planet was quite brilliant, but when projected on to the surface of the planet, during a transit, it became less and less bright until when near the central meridian it was very dark, in fact nearly as dark as its own shadow. This was observed on January 22 and March 12, and the same phenomenon, somewhat less marked, was observed in the case of the first satellite on March 27. As the satellites were projected on the bright equatorial band of the planet, it follows that the albedo of this region must be greatly superior to the albedoes of the two satellites.

A BRIGHT METEOR.—No. 4258 of the *Astronomische Nachrichten* contains a record of a bright meteor observed by Dr. J. Kaván at the Prag-Smichow Astronomical Institute on November 16, 1907. During its flight the meteor was seen to explode into two parts, but no trail, or detonation, was observed. The brightness of the object was about equal to that of Venus, and its flight, as observed by Dr. Kaván, was from $\alpha = 196^\circ{\cdot}2$, $\delta = +57^\circ{\cdot}7$, to $\alpha = 162^\circ{\cdot}9$, $\delta = +46^\circ{\cdot}7$; simultaneous observations by Herr L. Štetka gave approximately the same positions for the appearance and disappearance.

LATITUDE VARIATION.—When the international latitude service was instituted in 1899 the Cincinnati Observatory was asked to cooperate, and has made continuous observations since. As changes in the star-list were made in 1906 it seemed to Dr. Porter to afford a good opportunity to discuss the observations made to that date; this he does in No. 16 of the Publications of the Cincinnati Observatory, giving an historical account of the observations, a description of the instruments and methods used, and a table of the observed latitudes day by day. From the yearly values given it is seen that the different years show considerable fluctuations, signifying that the annual digressions are not symmetrical with reference to the determined mean position.

## ARCHÆOLOGICAL EXPLORATION IN GUATEMALA.

THE first part of the fourth volume of the Memoirs of the Peabody Museum, Harvard University, is devoted to an account of exploration by Mr. Teobert Maler in the valley of the Upper Usumatsintla, or the Usumacinta, as it appears in some modern maps, a river rising in Guatemala, falling into the Gulf of Mexico, and forming for part of its course the boundary between the Peten province of Guatemala and the Chiampas of Mexico. The exploration has thrown much new light on the geography of a region which has up to the present been very imperfectly explored. It is a wild country largely covered with tropical jungle, the main industry, that of lumber, attracting a particularly disreputable class of workmen, while agriculture is confined to a few scattered maize plantations. The author gives a very gloomy account of the population. "The dubious elements," he says, "sunk in sloth, filth, and every possible vice, whose miserable habitations are met with here and there, are constantly shifting since they acquire no fixed property rights." Whoever commits murder across the Mexican border takes refuge in Guatemala, and *vice versâ*. Attempts are, of course, made to secure the extradition of offenders, but these are generally unsuccessful. In fact, the negro is gradually taking the place of the Spanish-Indian population, which, having become enervated and degraded, is rapidly dying out.

The difficulty of exploration is naturally increased in such a country by the failure of the so-called Government to enforce law and order. Further, in Spanish times many of the old native names were replaced by those of Christian saints. The few that have survived to our days have been supplanted by political catch-words, Progresso, Libertad, and the like. More serious is the damage to these ancient buildings, which the State seems unable to prevent. Mr. Maler tells a curious story which appears to show that certain valuable stelæ were destroyed during an attempt by a Government official to prepare moulds of the sculptures for the Chicago Exhibition. It is quite time that the American Government intervened to preserve these wonderful structures.

FIG. 1.—Photographs at entrance of Tularosa Box Canyon below Delgars.

Taking all these obstacles to archæological inquiry into account, it is only natural that Mr. Maler's survey was little more than a reconnaissance. He had no opportunities for excavation, but was able to procure photographs and moulds of the most important remains. The four great groups of ruins were visited—those at the so-called Altar de Sacrificios and the more important sites, Itsimté-Saclue, Seibal, Cankuen—the order of their occurrence along the course of the river. Of these, the Seibal site seems to be the most promising, though nothing so interesting as the great sacrificial altar, a mass of reddish sandstone 160 cm. in diameter, was discovered here. In the other sites the most remarkable remains are the groups of stelæ or pillars which have survived, while the buildings to which they formed an adjunct are in such a state of decay that without excavation little of their character can be ascertained. The stelæ bear usually the representation of a figure, probably hero, priest, deity, or all combined, with various emblems and accessories, following generally the type characteristic of Central American art. In some cases the figure is seated in European fashion on a sort of throne. In one stela at Seibal he holds in his outstretched right hand a large sawfish lance, and in his left a pouch decorated with elaborate arabesques and loops. In another two personages sit in Turkish style before an altar, at which they are performing some sacred rite. More remarkable is the "tiger-paw man," whose hands and feet are covered with tigers' paws fastened by

FIG. 2.—Cliff-dwellings, west fork of the Gila.

bandages to wrists and ankles. In another sculpture the hideous face of the figure seems to be masked by the flayed skin of a human victim. Indeed, as might have been expected, human sacrifice seems to have played a leading part in the cruel religious rites of this people.

Mr. Maler does not venture an explanation of the symbolism, nor does he speculate on the origin and significance of these sculptures, which cannot be interpreted until the buildings to which they were attached have been fully examined. Meanwhile, he has done good service in collecting drawings, moulds, and photographs of a remarkable series of monuments, which under the present government of the country are in imminent danger of destruction before they can be subjected to careful scientific examination.

## *THE NEW BUILDINGS OF THE UNIVERSITY OF LEEDS.*

THE opening of the new buildings of the University of Leeds by the King, who was accompanied by the Queen, was briefly recorded in NATURE of July 9. A visit on the part of the Sovereign to a modern university, though not a unique occurrence, is sufficiently rare to be regarded, at least by the favoured institution, as an historical event. It is a Royal tribute to learning, cultivated not, as heretofore, in the silent precincts of sombre, mediæval halls, but strenuously pursued within earshot of busy factories and the hum of city life. It is, moreover, a public recognition and encouragement of the aims of a community which has provided from its own resources a centre of active scientific and academic life.

*Historical.*—Although the Leeds School of Medicine, which dates so far back as 1831, represents the oldest branch of the University, it is the Yorkshire College of Science, founded in 1874, which forms its real nucleus, the School of Medicine being incorporated in 1884. The College was then a modest block of buildings near the centre of the town, and began its first year with three professors and one student.

The first important development of the College of Science occurred in 1877, when it took over from the University Extension Committee the teaching of arts subjects, and became the Yorkshire College. In the same year the foundation-stone of the present buildings was laid by the late Dr. Thomson, Archbishop of York.

The Clothworkers' Company, the generosity of which to the technical departments of the college is as conspicuous as it is consistent, undertook the first section of the college buildings by erecting the textile industries and dyeing departments at a cost of 70,000*l.*

In 1887 the Yorkshire College entered the Victoria University as its third constituent college, and thus obtained the privilege of preparing its students for its own degrees.

To pass briefly in review the more recent developments, we must record the building of the Baines wing as a memorial to Sir Edward Baines, which was opened by the Prince and Princess of Wales (their present Majesties) in July, 1885; the building of the leather industries department in 1889 at a cost of 5668*l.*, mainly defrayed by the Skinners' Company; the founding of the agricultural department in 1890; and the building of the library, college hall, and medical school in 1894.

In 1903, when the union of the three constituent colleges of the Victoria University was dissolved and the Yorkshire College became the University of Leeds, the Privy Council, in recommending the grant of a university charter, stipulated that the capital of the institution should be increased.

The council has now succeeded in raising a little more than 100,000*l.*, more than half of which has already been expended in extensions, constituting the new buildings which His Majesty the King, as visitor of the University, opened on July 7.

The new buildings, the design and erection of which have been entrusted to Mr. Paul Waterhouse, comprise the main block extension in College Road for the arts and education departments, the temporary building for physics and chemistry, the mining, fuel, and metallurgical block, the laboratories for electrical engineering, the extension of the mechanical engineering building, certain additions to the textile department, and a central boiler house. The first of them in date of completion is the laboratory for mining, fuel, and metallurgy. The building was erected and equipped mainly from a fund of about 8000*l.* contributed by the Yorkshire Coal Owners. It stands by itself near the main university buildings, and is a simple three-storied red-brick structure. It is divided into two departments, that of mining, which is mainly on the ground floor, being under the supervision of Prof. Thompson, whilst the fuel and metallurgy department, under Prof. Bone, is housed mainly on the first floor.

*The Mining Department.*—This includes a lecture-room capable of seating fifty students, which it shares jointly with the department of fuel and metallurgy; a drawing office, which is equipped with surveying instruments; a general mining laboratory for the study of ore dressing and coal washing, which contains laboratory crushing and sampling machines, small jigs, slime tables, vanning shovel, and gold-washing pans, with the necessary assaying equipment for testing the products. Adjoining is an annexe for larger sized coal-washing and ore-dressing machinery, and includes a stone breaker, Cornish rolls, a stamp battery, jigging screens, &c. There are also fans and galleries for demonstrating the principles of ventilation of coal mines, and a photometric and lamp room for the study of safety-lamps and of different methods of gas-testing as ordinarily employed in collieries.

*The Gas Engineering, Fuel, and Metallurgy Department.*—This includes a large furnace-room, a general laboratory more especially for gas and fuel investigations, a balance and galvanometer room, stores, private laboratory, and a museum with a lecture-room on the top floor. The department represents a somewhat new departure in technical training, for in addition to the usual work connected with the study of metallurgy, it is laid out for the experimental study of different kinds of fuel and for preparing students for the working of gas plant for lighting and heating. In this connection it may be mentioned that the department is receiving financial assistance from the Institute of Gas Engineers in the form of an endowment of 500*l.* a year, which is being raised by the efforts of Sir George Livesey, and a fellowship of 100*l.* a year for research in connection with the gas industry. The furnace-room is equipped for the practical study of the characteristics of metals and alloys. The whole length of the room along one side is furnished with furnaces standing on stone slabs, including a full range of gas crucible furnaces, oil cyclone furnaces, a gas reverberatory furnace, muffle, sagger, and retort furnaces, with blast driven by a Crowell blower. Half the floor space is occupied by machines for testing the mechanical properties of metals and alloys, a rolling mill for reducing ½-inch rods to ¼-inch section, tensile-testing machine, a torsion-testing machine, and a set of electrically driven machines for cutting, grinding, and polishing sections, and preparing them for microscopic examination and photography. Adjoining the furnace-room is a laboratory with a special installation of apparatus for research on gaseous explosions under pressure, a compressing plant for obtaining compressed gases up to 200 atmospheres, and bench for analysis of coal, steel, &c.

The furnace and adjoining balance-room contain a complete installation of recording electrical and optical pyrometers, and the laboratory is also equipped with gas and bomb calorimeters for calorimetric determinations and apparatus for gas analysis. The equipment of these laboratories has been carried out at a cost of about 1000*l.*

*The Electrical Engineering Department.*—This department has been removed from its very cramped quarters in the main block, and now occupies a new and spacious building specially arranged, and standing by itself on the north side of the north quadrangle. It comprises a lecture theatre, drawing office, and photometer room equipped with the latest standards and apparatus for the measurement of the candle-power of electric glow and arc lamps, gas burners, &c.; a transformer room supplied with low- and high-pressure static transformers, rotary and electrolytic rectifiers, and apparatus for investigating efficiency of such plant; an instrument room, equipped with pressure, current and power standards, and a variety of testing apparatus; an electromotor room, with eight types of motors for continuous current and for single, two- and three-phase alternating currents, including a 500-volt 25-B.H.P. tramway motor; a dynamo room with eight pairs of motor-driven generators and rotaries, each having its own switch-panel, and developing from 4 h.p. to 30 h.p. at almost any pressure and periodicity. These sixteen machines are nearly all of the latest types, and comprise series, shunt and compound wound generators, single-phase, two-phase, and three-phase alternators, a double commutator, continuous current rotary, and a polyphase rotary converter; and, finally, an electrical engineering laboratory with all the necessary apparatus for instruction in the principles and practice of the subject.

*Physics Department.*—Prior to 1884, when the present lecture-room and laboratory were erected, the number of students taking practical work was extremely small, and the accommodation provided was regarded at that time as ample. From 1884 to 1898 the number of laboratory students increased eight-fold, and accommodation for them could only be found by annexing and utilising various cellars and underground corridors. In 1898 the Department had about 100 students, and comprised 220 square yards on two different floors, serving for all but electrical work, and 300 square yards of cellars, in which electrical experiments had to be carried on. Subsequently, a dark room of 150 square yards in the form of a corrugated iron building was added for advanced optical work, and another cellar of 200 square yards for elementary physics. The new premises, which consist of a one-storey shed covering the former tennis courts, will add about 1600 square yards, and will be divided into sections for elementary and advanced work. It is anticipated that the space will not only accommodate the present number of students, but will allow of an increase up to 50 per cent. It is impossible, however, that the present structure should have a very long life. Glass-roofed sheds and thin brick walls do not furnish ideal conditions for a physical laboratory, and it is anticipated that as soon as funds allow, a building having some relation to the importance of the subject and the large number of students in attendance will be erected.

*Organic Chemistry Department.*—The history of this department begins with the foundation of a lectureship and its recognition as a separate department in 1891. There was then no special provision for the study of practical organic chemistry. The department was first housed in a private laboratory and furnace-room on the ground floor; but as the number of students increased, additional accommodation had to be found, and a portion of the large lecture theatre was partitioned off, providing bench room for twenty-two students. The new temporary one-storey building, which adjoins the new physical laboratory, will double the present bench space, as well as provide a private laboratory for the professor and a temporary laboratory for occasional classes. As in the case of the Physics Department, it is only lack of funds which prevents suitable provision being made for this branch of practical chemistry.

*Civil and Mechanical Engineering Department.*—This department was founded in 1876, and for eight years was carried on under some difficulties as to space and equipment. In 1884 a special fund was raised by the engineers of the district for the building of a new department, with laboratories, drawing-office, lecture-rooms, &c. The accommodation proved sufficient for some years, but as the number of students increased, it was found necessary to absorb into the department other small rooms of the college, and in 1891 the authorities found themselves compelled to limit the number of students to eighty. The new block is an extension of the 1884 buildings on the north side, and contains a laboratory specially fitted up for hydraulics and one for applied mechanics, as well as an extension of the drawing-office.

This brief history of the university and the account of its new buildings is a record of small beginnings and steady growth. Each department has passed through a similar series of phases, a more or less rapid rise in numbers causing increasing pressure from within, which has led to expansion by various temporary expedients until the department has had to detach itself from the parent building and set up house for itself. There may be now an interval of apparent repose; but there is little doubt that the process will repeat itself. Temporary buildings will have to give place to permanent structures, properly adapted for the purpose which they have to serve, and physics and chemistry, the largest of the departments, will soon have to receive their share of attention. It will only be by constant appeals to the generosity of the public that the university will be able to fulfil the requirements which high teaching efficiency and modern equipment demand, if it is adequately to serve the interests of the city and county in which it is placed.

We have only referred to the work and appliances for ordinary teaching. The pursuit of research is eagerly encouraged, but here again the small sum at the disposal of the council for post-graduate fellowships and maintenance grants greatly reduces that form of assistance which heads of departments naturally look to in carrying out original investigations.

This form of assistance the Treasury has, unfortunately, not yet recommended in allocating funds for research, but its recognition cannot be urged too strongly or too frequently.

J. B. C.

## A CAPE CATALOGUE OF STARS.[1]

THE most recent catalogue of stars emanating from the Cape Observatory contains the places of 1680 stars for the equinox 1900·0, deduced from observations made during the years 1905–6 under the direction of Sir D. Gill. The introduction, which is signed by Mr. S. S. Hough, explains that the stars observed with the old non-reversible transit circle in the above-mentioned years, the places of which are included in this catalogue, are chiefly stars south of declination $-36^\circ$ required by Prof. Boss in connection with the formation of his fundamental catalogue. The catalogue also includes stars the places of which are required in connection with the geodetic survey of South Africa, and stars of which occultations by the moon have been observed.

With regard to the right ascensions, it may be noted that the places of stars employed for the determination of clock-error were those of Newcomb's Fundamental Catalogue. It is also to be noted that the correction has been applied for the observers' personality depending on magnitude. The existence of this kind of personality was first detected by Sir D. Gill in his discussion of the places of the comparison stars used in connection with his determination of the solar parallax by observations of Mars in 1877. It is fit and proper, therefore, that the Cape Observatory should be a pioneer in this direction of refinement, and should include this correction, as a matter of routine, in the ordinary reductions of meridian transits of stars.

The declinations have been reduced with refractions based on the Pulkowa tables and adopted mean latitude of the transit circle, $-33^\circ\ 56'\ 3''{\cdot}50$. The observations have also been corrected for variation of latitude depending on the Chandler polar motion, in accordance with data supplied by Dr. Albrecht. Here again we note the anxious care of the authorities of the Cape Observatory to produce work of the highest excellence and refinement.

The catalogued places of the stars have been reduced by the application of precession alone (based on Newcomb's determination of the precessional constant) from the mean epoch of observation to 1900·0, but the necessary corrections for the inclusion of proper motions are given in a separate column. The adopted values of the latter elements have been taken from Newcomb, Boss, or Auwers.

In view of the uncertainty attaching to the proper motions of stars south of the zenith of the Cape, it is of interest to exhibit the corrections to the places of Prof. Boss's catalogue of 627 standard stars (*Astronomical Journal*, Nos. 531–2), derived from the comparison with the

[1] "Catalogue of 1680 Stars for the Equinox 1900·0 from Observations made at the Royal Observatory, Cape of Good Hope, during the Years 1905–6." Under the direction of Sir David Gill, K.C.B., F.R.S., with Introduction by S. S. Hough, F.R.S. Pp. xii+44. (Edinburgh: Printed for H.M. Stationery Office by Neill and Co., Ltd., Bellevue, 1907.) Price 3s.

places of the Cape catalogue before us, for the stars specified above, when arranged in zones of declination:—

| South decl. | | $\Delta\alpha$ s. | | $\Delta\delta$ " | | No. of stars |
|---|---|---|---|---|---|---|
| 34–46 | ... | −0·004 | ... | +0·33 | ... | 39 |
| 46–56 | ... | −0·008 | .. | +0·42 | ... | 34 |
| 56–66 | ... | +0·009 | ... | +0·45 | ... | 30 |
| 66–80 | ... | −0·049 | ... | +0·44 | ... | 16 |

The discordances in right ascension for the first three zones are not larger than would be anticipated, bearing in mind the fact that Prof. Boss has not corrected his places for personality depending on magnitude. The mean correction for the polar zone is, however, quite uncertain, the mean (without regard to sign) of the individual discordances from the mean value entered above being as much as 0·102s., pointing to the extreme uncertainty with which right ascensions of even so-called "standard" stars situated in this portion of the sky are carried forward for a term of years.

There appears to be a well-marked systematic discordance of about 0″·4 in the declinations. This, however, is not the place in which to inquire into the origin of this discordance, which will doubtless receive due attention at the hands of Prof. Boss.

A melancholy interest attaches to the publication under review. Sir D. Gill, in a short preface, addresses a few words of farewell to the members of the staff of the Cape Observatory, referring to this catalogue as the last that will probably appear in connection with his name. The splendid work performed by Sir D. Gill at the Cape Observatory need not be emphasised here. It must be a satisfaction to him, as well as to astronomers all the world over, that he was able to accomplish another excellent piece of work before the close of his official career, during which he has done so much to enhance the fair fame of British astronomy.

A. M. W. D.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—Dr. John Cadman, one of H.M. inspectors of mines, has been appointed to the chair of mining rendered vacant by the resignation of Prof. R. A. S. Redmayne.

GLASGOW.—The University Court has established a lectureship in bacteriology, and appointed Dr. C. H. Browning as the first lecturer. The Court has also established a lectureship in geography, to which an appointment will be made in October.

THE annual meeting of the Midland Agricultural and Dairy College will be held on Monday, July 27, at 3.15 p.m., when the report on the year's work will be presented. The Duke of Portland will address the meeting and present the certificates gained during last session.

To secure the best results, it is highly important that technical colleges should work in close connection with the needs of local industries. A distinguishing characteristic of the prospectus of the day classes at the Heriot-Watt College, Edinburgh, is the excellent system of co-ordinating the more theoretical work of the college with the practical experience gained during apprenticeship. Arrangements have been made with several of the leading firms of engineers in Edinburgh by which students of the college are allowed to begin their apprenticeship at the end of the second winter college session, returning to college the following winter to complete their third winter session. Students holding the college diploma have their term of apprenticeship reduced by a year, and in some cases either reduced premiums are charged to college students or the premiums are entirely dispensed with. The Edinburgh and Leith Corporations' gas commissioners, also, have agreed to allow students who have been three years in the chemistry department of the college to spend four summer months in the laboratories of their gas works, and thus to obtain a thorough knowledge of the analysis of fuels, products of combustion, coal gas, and coal distillation products. A two years' course of instruction in mining, again, has been arranged, which is accepted by the Home Office as equivalent to the two years' underground training required of those who wish to obtain the mine manager's certificate. In connection with the department of technical mycology, an arrangement has been made between the college and the Brewers' Association of Scotland by which brewers' apprentices who have completed satisfactorily an approved course will receive a joint certificate awarded by the association and the college. Students who already hold a university science degree can obtain special post-graduate instruction in several departments of technology. These instances are typical of the successful efforts which are being made in Edinburgh to make technical instruction of real benefit to those employed in industrial pursuits.

ON the occasion of the visit of the King and Queen on July 9 to open the Royal Edward Dock at Avonmouth, an address was presented to their Majesties by the council and senate of the Bristol University College. After detailing the efforts which have been made to provide Bristol with a complete system of education, the address proceeds:—"We humbly trust that your Majesty will regard with satisfaction the provision that has thus been made in our city for education in its various grades, and will look with favour on our hope that our educational system will be completed and crowned by the establishment of a University in Bristol similar to those founded in recent years in other important cities of the realm. The public spirit and generosity lately shown by a member of a well-known Bristol family in promising the sum of one hundred thousand pounds towards the endowment of a Bristol University leads us to anticipate that with the help of other liberal benefactors our city may shortly be in a position to crave of your Majesty the grant of a Royal Charter for the incorporation of this University." During the course of his reply, the King said:—"It is now recognised by the great municipalities and other education authorities of my kingdom that it is their duty to provide facilities for the acquirement of special knowledge, so that young men may be enabled to obtain efficient equipment, both literary and technical, without travelling to distant Universities to obtain it. The generous emulation of rival cities in this respect is necessarily beneficial, for every addition to the practical efficiency and culture of a community, and every stimulus thereby supplied to others, are gains to the whole nation. I will take care that your petition for a grant of a charter for the incorporation of a University in Bristol is referred to a committee of my Privy Council, who will give it careful and sympathetic consideration, and then submit to me their advice." The Society of Merchant Venturers also presented an address in which reference was made to the willingness of the society to maintain a faculty of engineering in the University.

THE Department of Agriculture and Technical Instruction for Ireland has for some years been very active in encouraging the teaching of science both in Irish secondary schools and technical institutes. Technical instruction also, through the efforts of the department, is being given successfully in numerous centres throughout Ireland. Illustrated accounts of the technical work in different districts are published in the Journal of the department from time to time, and afterwards re-published for wide distribution; the latest pamphlet to be issued in this way is a well illustrated description of the facilities for technical instruction in Queenstown, by Mr. George Thompson, the principal of the technical school in that town. The department also does very useful work in providing science teachers in Irish secondary schools with careful guidance as to the best methods of teaching and the most suitable courses of work in science for boys and girls in secondary schools. We have received copies of the revised syllabuses in physics and in physiology and hygiene. The syllabuses, in addition to a general introduction describing the aim and object of the instruction, outline experimental courses of study for each of the four years during which science is taught in the secondary school. During the first two years of their study of science the pupils investigate practically the simple fundamental principles of physics and chemistry, while during the third and fourth years some specialisation is allowed, and the study becomes more intensive. The syllabuses are well worth the careful attention of all teachers of science in secondary schools, whether they are teaching in Ireland or elsewhere. We notice, too, that the department will, in August, 1908, award not more than six industrial scholarships—of the value of 80*l*. each, and renewable for a second and third year—to persons engaged in industries, such as the woollen, linen, leather, and tanning industries. The object of these scholarships is to enable selected persons, who must already have been engaged in one of the higher branches of the industry, to take a full course of instruction in an institution providing special courses of an approved character, with the view of training them for the management of such an industry. Candidates will be required to show that there is a reasonable expectation of their being able to find suitable employment in the industry in Ireland after the termination of their scholarships.

THE installation of Lord Morley of Blackburn as Chancellor of the University of Manchester took place on July 10. Replying to an address presented to him by the Vice-Chancellor, Mr. A. Hopkinson, Lord Morley dealt with the functions of universities. He urged those present not to allow technical teaching, valuable as that science was, to throw into a second place the true object and scope of a University. It is a remarkable and encouraging fact, he said, that there has been no disposition during the last twenty or twenty-five years among the many benefactors of these institutions to limit their benefactions. On the contrary, some of the most remarkable of these benefactions have been for music, for philosophy, for theology, and for literature. This would seem to justify the hope that merely and purely technical teaching will not drive out teaching of the University type. After the installation Lord Morley and Mr. Arthur Balfour were entertained at luncheon. Mr. Balfour, in replying to a toast, said:—"In order to pursue knowledge to the best advantage, knowledge must be pursued for her own sake; and she is more likely to be successfully pursued for her own sake in a great academical house than by any other method or machinery which the wit of man has as yet devised. As knowledge is to be pursued for its own sake, mankind has found its greatest instrument for the better prosecution of knowledge in science. The great advancement of mankind is to be looked for in our ever-increasing knowledge of the secrets of nature—secrets, however, which are not to be unlocked by the men who pursue them for purely material ends, but secrets which are open in their fulness only to men who pursue them in a disinterested spirit. The motive power which is really going to change the external surface of civilisation, which is going to add to the well-being of mankind, which is going to stimulate the imagination of all those who are interested in the universe in which our lot is cast, that lies after all with science. I would rather be known," Mr. Balfour continued, "as having added to the sum of our knowledge of the truth of nature than anything else I can imagine. Unfortunately for me, my opportunities have lain in different directions; but the happiest of men surely are those whom fortune has given time, leisure, the opportunity, and, above all, the genius which enables them to penetrate into the secrets of nature in such a way that, perhaps unknown to themselves, unknown even to the generation in which they are born, something will have been given to mankind which posterity can develop into some great practical discovery on which the felicity of mankind may depend."

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, March 12.—"On Reciprocal Innervation in Vaso-motor Reflexes and the Action of Strychnine and of Chloroform thereon." By Dr. W. M. **Bayliss**, F.R.S.

(1) In depressor reflexes there is, along with inhibition of tone in the vaso-constrictor centres, an excitation of vaso-dilator centres. This has been shown in the cases of the submaxillary gland, the penis, the hind-limb, the external ear, and probably the tongue.

(2) Correspondingly, in pressor reflexes, along with excitation of constrictors, there is, in appropriate conditions, inhibition of dilator tone. This is, however, more difficult to demonstrate.

(3) Similarly, in the local, or Lovén, reflexes, there is also both excitation of dilators and inhibition of constrictors.

(4) The action of strychnine is to convert the inhibitory phase of all vascular reflexes into an excitation, so that:—

(5) The depressor nerve produces a rise of blood-pressure under full doses of the alkaloid. It does this by exciting the constrictor centre by the same mechanism which normally inhibits it.

(6) In the "dilator" animal under strychnine, pressor reflexes become depressor, in that inhibition of dilators is converted into excitation.

(7) Various parts (synapses) of the reflex arc are differently sensitive to the alkaloid, the synapse of the pressor fibres with the constrictor centre being the first to show paralysis as the dose is increased.

(8) In the "dilator" animal strychnine causes a fall of blood-pressure on injection by exciting dilator centres. In the normal animal the first dose causes a rise, and subsequent ones a fall of pressure, since the first dose, if not too small, after exciting the vaso-constrictor centre, paralyses the synapses concerned, so that the simultaneous excitation of the dilator centres can now make itself felt.

(9) The excitation of constrictors produced by reversal of inhibition is more resistant to the alkaloid than that produced in the normal way.

(10) Asphyxial blood does not act directly on the efferent constrictor neurones, since it has no action at a stage of strychnine poisoning at which the depressor still excites constriction, by reversal of inhibition.

(11) Chloroform converts pressor into depressor reflexes (in the rabbit) by reversal of excitation of constrictors into inhibition.

(12) This effect of chloroform is not exerted on the efferent neurones directly, but at some point considerably earlier in the reflex arc. This is shown by the fact that asphyxial blood causes rise of pressure when excitation of sensory nerves causes fall.

June 4.—"The Optical Constants of Gypsum at Different Temperatures, and the Mitscherlich Experiment." By Dr. A. E. H. **Tutton**, F.R.S.

The experimental work on selenite now described confirms the author's previously published conclusion, derived from other examples, that the phenomenon of crossed-axial-plane dispersion is due to very low double refraction, combined with close approximation of the intermediate index of refraction to one of the extreme indices, and to the fact that change of wave-length of the light or change of temperature, or both, cause the intermediate index to approach still nearer to the extreme one in question until it becomes identical with it, and eventually to pass it, the relative positions of the two indices thus becoming reversed. The uniaxial rectangular cross and circular rings are produced at the critical point of identity. This critical point is a function of both wave-length and temperature, being a fixed one only for a particular wave-length and specific temperature. The temperature has a maximum for wave-length 573 on the greenish-yellow side of the D lines (589). The optic axial angle has a maximum for the same wave-length 573, for all temperatures below that of the crossing of the optic axes, and a minimum for temperatures superior thereto up to the temperature of decomposition (120°) of selenite. The change of orientation of the median lines (bisectrices of the optic axial acute and obtuse angles) within the symmetry plane, at any specific temperature, also exhibits a critical limit for this greenish-yellow light of wave-length 573, which is thus a very important radiation in connection with the optics of selenite. The range of temperature which includes the production of the uniaxial figure for all colours of the spectrum does not exceed 4°, varying in different crystals from 3°·5 to 4°. The absolute temperatures of crossing for the four crystals investigated varied 9°, the maxima (for wave-length 573) varying from 105°·5 to 114°·5, corrected for conduction of crystal holder.

**Zoological Society**, June 16.—Dr. Henry Woodward, F.R.S., vice-president, in the chair.—Photographs and fragments of skin and bone of a mammoth and a rhinoceros discovered in an ozokerite mine at Starunia, Galicia:

Dr. A. Smith **Woodward.** The carcases of these animals appeared to have found their way into an old marsh saturated with petroleum, which had completely preserved them. The photographs and specimens had been received from Dr. George von Kaufmann, who intended to present them to the British Museum.—The lower jaw of a young Canadian beaver in which there was present on each side a small conical tooth anterior to the deciduous premolar: Dr. C. I. Forsyth **Major.** The supernumerary premolar was considered to be a case of atavism.—Drawings made from examples of two species of Castor from the East Runton forest-bed: Dr. Forsyth **Major.** It was remarked that truly forest-bed species were found in association with Pliocene species.—Photographs of Pliocene Bovinæ from specimens in the Florence Museum: Dr. Forsyth **Major.** These unpublished figures showed the great variability of the Pliocene Bovinæ. The exhibitor endorsed Falconer's opinion that these Pliocene Bovinæ were nearly related to the primitive buffaloes from the Siwaliks.—Mammals from the provinces of Chih-li and Shan-si, N. China, collected by Mr. M. P. Anderson, being the tenth of the series of papers on the results of the Duke of Bedford's zoological exploration of eastern Asia: Oldfield **Thomas.** Very little material had hitherto existed from this part of northern China, although a certain number of specimens had been sent to Paris by Père David, and it was therefore of great importance to have a series representing the species he discovered for comparison with mammals from other regions. The present collection consisted of about 100 specimens, belonging to twenty species, of which several are new.—A case of imperfect development in *Echinus esculentus*: J. **Ritchie** and D. C. **McIntosh.**—The minute structure of calcareous sponge-spicules: Prof. E. A. **Minchin** and Dr. D. J. **Reid.** The primary object of this investigation was to demonstrate, by means of photomicrographs, certain structures, the existence of which had been strenuously denied by some of the most competent of previous investigators, namely, the presence, after the spicules had been cautiously decalcified, of a residue in the form of an axial filament which could be stained and rendered evident by certain dyes, in addition to the sheath universally acknowledged to exist. The axial filament was found to be very distinct in the spicules of Clathrinidæ, but much less so in those of Leucosoleniidæ and Heterocœla. Incidentally, the study of the axial filaments led to some interesting conclusions regarding the comparative morphology of the two principal types of spicules, monaxon and triradiate, occurring in calcareous sponges.—*Cyaniris chennellii* of de Niceville: Dr. T. A. **Chapman.** It was shown that this was not a Cyaniris (Celastrina, Tutt), but belonged to a new genus near to Everes, and that a specimen in Colonel Bingham's collection, placed with *chennellii*, was a species almost entitled to be placed in Cyaniris, for which he proposed new generic and specific names. Another specimen of the latter species was in the Tring Museum. It was suggested that de Niceville had both these species together in dealing with *chennellii*, and unfortunately selected as his type the one that was not a Cyaniris. The two forms probably fly together, and are therefore mimetic.—(1) A contribution to knowledge of the batrachian *Rhinoderma darwini*; (2) some notes upon the anatomy of *Chiromys madagascariensis*, with references to other lemurs: F. E. **Beddard.**—*Leucocytozoon musculi*, sp.n., a parasitic protozoon from the blood of white mice: Annie **Porter.** The parasites occur in mononuclear and transitional leucocytes, and free in the plasma. The free trophozoites are gregariniform vermicules, their average size being 10·9 $\mu$ long by 5·1 $\mu$ broad.—Descriptions of African micro-Lepidoptera: E. **Meyrick.** 108 species and eleven genera of Tortricina and Tineina from the African region (especially the Transvaal) were described as new.—A collection of calcareous sponges made by Mr. Cyril Crossland in the Cape Verde Islands: A. G. **Thacker.**

**Royal Microscopical Society,** June 17.—Mr. A. N. Disney in the chair.—*Exhibits.*—A lens for high-power microscopy to obviate the use of the oscillating screen: J. W. **Gordon** and H. Fletcher **Moulton.**—A small, simple microscope by Cary: A. **Skinner.** The instrument was only $4\frac{3}{4}$ inches high. It was provided with a plane mirror and a mechanical stage having movements of 4/10-inch horizontally and $\frac{1}{2}$-inch vertically. Focussing the object was effected by moving the stage by rack and pinion, the teeth of the rack being set obliquely, as in modern microscopes.—Micro-slides illustrating the structural parts of the chick at various stages of its development from about two days to $4\frac{1}{2}$ days: A. **Flatters.**—Stereophotomicrographs: Wm. P. **Dollman.** These were photographs of Alveolina ×6, fungus in eye of horse×350, statoblast of a fresh-water polyzoa from Bombay×350, *Biddulphia antediluviana* from Baltic mud×350.—*Papers.*—Cycloloculina, a new generic type of Foraminifera found on the shore of Selsey Bill: E. **Heron-Allen** and A. **Earland.** The paper was illustrated by a large map, on which the localities where the specimens were collected were pointed out. A number of slides of specimens under microscopes, and lantern-slides were shown upon the screen. Mr. Earland remarked that he believed they would eventually trace the specimens to some Eocene deposit which was not exposed above low-water mark. The source of origin could not be very far away from the place of discovery, for the specimens were too fragile to travel any considerable distance.—Illuminating apparatus for the microscope: J. W. **Gordon.** The light from a Nernst lamp is transmitted through a glass rod, the end of which nearest to the lamp is cut to a plane surface and finely ground; the other end has a polished surface, flat or lenticular in form, according to the user's requirements.—*Corethron criophilum*: E. M. **Nelson.**

**Linnean Society,** June 18.—Dr. D. H. Scott, F.R.S., president, in the chair; afterwards, Dr. A. Smith Woodward, F.R.S., vice-president.—Altitude and distribution of plants in southern Mexico: Dr. Hans **Gadow.**—Reports on the marine biology of the Sudanese Red Sea from collections made by Mr. Cyril Crossland, together with collections made in the Red Sea by Dr. R. Hartmeyer. On the Bryozoa, part i., Cheilostomata: A. W. **Waters.** The author enumerates thirty-nine species of Cheilostomata collected by Mr. Crossland, and twenty-three collected by Dr. Hartmeyer; besides these, eighteen other species are known from the Red Sea, making eighty Cheilostomata in all. The distribution of Red Sea species is in most cases very wide, often extending from the Atlantic to Eastern seas.—The algæ of the Yan Yean reservoir: G. S. **West.**—*Gardenia Thunbergia* and its allies: Dr. **Stapf** and J. **Hutchinson.** These Gardenias, fifteen in number, form the bulk of the section Eu-Gardenia in Africa, and extend over the whole of the continent with the exception of the temperate north. Owing to the instability of certain characters and the scantiness of the material in the older collections, they have not been well discriminated so far, with the result that *Gardenia Thunbergia* came to cover finally half a dozen perfectly distinct species ranging all over Africa, whilst the plant originally described under that name is actually confined to a limited area in South Africa. The distinctive characters of the species admitted—of which six are here described for the first time—are set out in key form, whilst their distribution and synonymy and full descriptions of the new species are given in the second part of the paper. It is also pointed out that the segregation of the "Thunbergia" group from the closely allied Indo-Malayan stock of § Eu-Gardenia must have taken place in pre-Tertiary times.—The marine algæ collected in the Indian Ocean by H.M.S. *Sealark*: A. **Gepp.**—Nudibranchs from the Red Sea, collected by Mr. C. Crossland: Sir Charles **Eliot.**

**Royal Anthropological Institute,** June 23.—Prof. W. Ridgeway, president, in the chair.—The Kurdish tribes of the Ottoman Empire: Mark **Sykes.** The tribes, of which the author distinguished about 323, inhabit that part of Asiatic Turkey between Uruma, in Persia, and Angora, in Asia Minor. Classification is difficult. They may be distinguished as nomadic, semi-sedentary, and sedentary, but any other kind of classification is almost impossible. As to religion, there are to be found among them Sunni Moslems, Shias, Devil worshippers, Pagans, Pantheists, and Christians. Linguistically, they are divided into a variety of dialects, which are said to form two broad divisions, Zaza and Kermanji. Physically, the most extraordinary contrasts are to be found. In Hakkiari they are small, wiry mountaineers; tall, slim horsemen in Irak; those north of Lake Van are clumsy, heavily built, big-boned, and hook-nosed; in north Mesopotamia they are full-bearded, with regular features; while to the north and west of Erzinjian the men are fair-haired and of ruddy complexion. In point of civilisation the contrasts are just as marked.

### Cambridge.

**Philosophical Society**, May 18.—Mr S. Ruhemann, vice-president, in the chair.—Radio-activity of solutions of potassium salts: N. R. **Campbell**. (1) All attempts to observe or to produce any difference in the activity of different samples of the same potassium compound in the same physical state have failed completely. No evidence has been obtained of any such separation of the activity as is to be expected, whatever view may be taken of the source of the activity. (2) The activity of a thick layer of a potassium compound is not accurately proportional to the amount of potassium which it contains. It is probable that the variation from strict proportionality is to be attributed to a difference in different compounds of the values of the ratio of the density of the substance to the absorption coefficient of the rays emitted by it. In the case of solutions, at least, the variations in the value of this ratio are surprisingly large and irregular. The ratio is not necessarily greater for the solution of greater density or greater concentration.—A preliminary note on an effect observed when palladium foil is heated in air at a low pressure: Rev. H. V. **Gill**. Strips of palladium foil were mounted in a glass tube so that they could be heated by means of an electric current. When heated in air at a pressure of about 0·15 mm. first to a dull red and then to a bright white heat, the palladium foil was seen to be surrounded by a purple-blue glow. This glow had all the appearance of a kathode discharge in a vacuum tube. There was no electric field except that due to the current which came from two storage cells to heat the foil. The glow gradually disappeared, and could not be again obtained from a strip which had been already used. This experiment was repeated many times, and with palladium foil obtained from different sources. The cause of this glow is being investigated.—The absorption spectra of some compounds of pyridine (second paper): J. E. **Purvis**. The results indicate that in these isomeric compounds the relative positions and the persistencies of the absorption bands are influenced by the type and the spatial positions of the atoms or groups of atoms introduced into the nucleus.—Further researches in the theory of divergent series and integrals: G. H. **Hardy**.—Some reactions of phenyliodidechloride and iodosobenzene acetate: H. H. **Hodgson**.—Integral forms and their connection with physical equations: R. **Hargreaves**.—The determination of the rate of chemical change by measurement of the gases evolved: F. E. E. **Lamplough**.

### Manchester.

**Literary and Philosophical Society**. May 12.—Prof. H. B. Dixon, F.R.S., president, in the chair.—Spore formation in the genus Chætoceros: Miss Nellie **Snape**. Spined resting spores occur during the late summer; these are set free by the breaking up of the Chætoceros filament and the throwing off of the old shells. Individuals of Chætoceros are also often seen containing a number of small rounded spore-like bodies formed by the contraction of the protoplasm and its aggregation round the chromatophores. The number of these bodies varies considerably, but their size is remarkably constant. It would appear rather probable that these spore-like bodies are really gametes, but confirmatory evidence on this point is at present lacking.—The mummy of Khnumu Nekht in the Manchester Museum: Miss Margaret A. **Murray**. The coffin was found in a rock tomb at Rifeh, near Assiout, in Upper Egypt, and dates from the XIIth Dynasty, or, roughly, about 2500 B.C. That this was a real mummy was shown by the fact that the nails of the hands and feet were carefully bound with threads so as to preserve them in position when the epithelium fell away. This proves the practice of mummifying, which rapidly disappeared on the introduction into Egypt of Christianity, to be more ancient than some have maintained, who give 1600 B.C. as the earliest date of its occurrence. The practice was held by some to be connected with the belief in re-incarnation. On the coffin were inscriptions said to be variants of the Pyramid text. Some of these read as follows:—"Thy mother Nut spreads herself above thee: she causes thee to be as a god without enemies"; "Comes to thee, comes to thee, thy mother Nut"; "To Anubis, Lord of Sepa, may he grant that thou cross heaven, and that thou reach land at the pure places which are in heaven."—Dr. **Cameron** gave an account of the anatomical features of the remains. The bones were remarkably slender. Measurements of the capacity and "indices" of the skull showed that it compared favourably with the average modern European type, whilst the limb bones rather tended towards the Simian character. There were indications that Khnumu Nekht was of lethargic habit, and spent much time in a squatting posture. His height was probably between 5 feet 3 inches and 5 feet 10 inches, and his age between sixty and seventy years. The teeth, with the exception of one, were intact, and only one of them showed any sign of decay, but all were extraordinarily worn, which showed that the food consumed must have been exceedingly gritty.

### Edinburgh.

**Royal Society**, June 22.—Prof. Ewart, F.R.S., vice-president, in the chair.—Equilibrium in the system water, and a pair of enantiomorph solids: Dr. W. W. **Taylor** and Dr. T. **Rettie**. The system investigated was water and the optically active tartar emetics, the systems water with *r* tartar emetic along with *d*- or *l*-tartar emetics being also included to complete the scheme. Series of confirmatory experiments were made with *d*- and *l*-sodium ammonium tartrates and sodium ammonium racemate. In the former case the transition temperature was unknown; it was determined by the solubility and dilatometer methods to be between 60° and 61° C. It was confirmed by crystallisation experiments above and below the transition temperature. The results show that the enantiomorph solids behave as two absolutely distinct phases, any mixture of the two being more soluble than either component alone; and the maximum solubility is possessed by the equimolecular mixture. Owing to the occurrence of labile equilibria, true equilibrium in each system was found to be attained much more slowly than was generally supposed. In some cases 20 days' shaking was found to be necessary.—The electrolytic conductivity of aqueous solutions of lactic acid, and on changes in conductivity accompanying the alcoholic fermentation: Dr. John **Gibson** and Andrew **King**.—An improved thermostat and other apparatus used in conductivity work: Dr. John **Gibson** and G. E. **Gibson**.—Determinations of the conductivity of concentrated solutions of good electrolytes:—(1) hydriodic and hydrobromic acids: Dr. John **Gibson** and Andrew **King**; (2) hydrochloric acid: Dr. John **Gibson** and W. H. **Paterson**; (3) ammonium bromide, lithium bromide, and sodium bromide: Dr. John **Gibson** and Dr. E. B. R. **Prideaux**.—The precipitation of certain chlorides by hydrochloric acid: Dr. John **Gibson** and Dr. R. B. **Denison**. These papers all bore more or less upon a general line of research which has occupied Dr. Gibson's attention for years. The discussion of the facts established was held over for a future communication. The improved thermostat was electrically controlled, the circuit of the incandescent lamps which supplied the heat being interrupted or closed (as the case might be) by an electromagnetic relay controlled by a modification of the usual form of cut-off. By means of this thermostat the temperature could be kept absolutely constant for months at a time.—Andrews's measurements of the compression of carbon dioxide and of mixtures of carbon dioxide and nitrogen: Dr. C. G. **Knott**. This completed a work which was begun by Prof. Tait in 1899 with the view of supplying the true pressures as indicated by the air and hydrogen manometers used by Andrews in his well-known experiments. See a letter by K. Tsuruta, of Tokyo, in NATURE, February 2, 1899, which directed attention to the importance of finding the true pressures instead of those given by Andrews and explicitly referred to by him as only provisional. With the assistance of Dr. Andrews's daughter, Miss M. K. Andrews, the experimental notebooks had been carefully and successfully investigated, and the data obtained from which the true pressures could be calculated.

### PARIS.

**Academy of Sciences**, July 6.—M. Bouchard in the chair.—A fundamental hypothesis implicitly admitted in the classical treatment of astronomy: J. **Boussinesq.** It has been implicitly assumed that the path of any planet with respect to the sun forms a closed trajectory described periodically. The tendency to make the simplest hypothesis consistent with the observed facts is unavoidable; thus the ancient astronomers assumed circular uniform motion for the stars, an assumption which had to be complicated as observations became more exact.—The triboluminescence of racemic compounds: D. **Gernez.** It has been shown by Tschugaeff that whilst with certain optically active bodies both the right- and left-handed constituents are triboluminescent, the racemic compound is not so. The author has filled up some gaps in Tschugaeff's table, and added fresh optically active substances, but is unable to confirm his hypothesis. There seems to be no general relation of cause and effect between triboluminescence of bodies and their symmetrical or unsymmetrical constitution.—The eclipse of the sun of June 28, 1908, at the Observatory of Lyons: Ch. **André.** The results of observations of contacts, chords, and angles of position. The last contact was partially obscured by clouds.—The action of metallic oxides on primary alcohols. The case of oxides undergoing reduction: Paul **Sabatier** and A. **Mailhe.** The simplest case is that of the oxides of antimony and bismuth, which, at 360° C., are reduced to metal, water and aldehyde being the only products. With $HgO$ and $MnO_2$ the oxidation goes further, some carbon dioxide being formed. The reduced metal in these cases shows no catalytic power, but with nickel, cobalt, lead, and copper the catalytic effects of the reduced metal are added to the reducing power of the oxides, and the reaction becomes more complicated. With some metals (iron, cadmium, tin) the oxides also can act catalytically.—The floating population on canals and public health: MM. **Chantemesse** and **Pomès.** The possibility of infection being carried in this way was overlooked in the legislation of 1902. Cases are cited showing how widely infection has been carried by canal boats, and the necessity of suitable prophylactic measures is pointed out.—Some new peculiarities of short-period variable stars: a method of distinguishing their effects from those due to dispersion in a vacuum: Charles **Nordmann.** It is shown that the results obtained by the method of monochromatic images can separate, for a numerous class of variable stars, the two classes of phenomena in question.—The variations of duration of twilight: Ernest **Esclangon.** The visibility of celestial objects, depending as it does on two factors, the apparent brightness of the sky and the transparency of the air, is a faulty method of observation; the photometric state of the sky is more suitable for quantitative study. The great influence of suspended particles in the air is pointed out, and the abnormal twilight of July 1 considered from this point of view.—The partial eclipse of the sun observed at the Observatory of Besançon on June 28, 1908: MM. **Brück, Chofardet,** and **Pernet.**—Observation at the Observatory of Marseilles of the partial eclipse of the sun of June 28, 1908: Henry **Bourget.**—A problem relating to the theory of partial differential equations of the hyperbolic type: A. **Myller.**—A new integrometer: M. **Jacob.** The apparatus described on May 11, 1908, allows the integration of the equation

$$y' = Ay^3 + By^2 + Cy + D,$$

if a particular solution of this equation is known. By slightly modifying the apparatus, the latter restriction is removed.—The useful weight of aëroplanes: Rodolphe **Soreau.**—The use of detectors, sensitive to electric oscillations, based on thermoelectric phenomena: C. **Tissot.**—Researches on ionised gases: A. **Blanc.** The method of measurement used was a modification of the alternating field method of Rutherford, and was applied to the study of mixtures of carbon dioxide and hydrogen, and air and carbon dioxide. The mobility in air of an ion produced in carbon dioxide is the same as if this ion had been directly produced in air, and this is true for ions of both signs.—The influence of temperature on the electromotive force of the cadmium element: R. **Jouaust.** The formula given in 1901 by Jäger and Lindeck for the variation in the electromotive force of the cadmium cell between 0 and 20 for an amalgam containing between 12 and 13 per cent. of cadmium has been confirmed. More recently, Smith has stated that between 10° and 20° C. amalgams of 10 per cent. and 12·5 per cent. show an identical relation; this, however, is now shown not to be true at 0° C., and the anomalies shown by the cells with 10 per cent. amalgam require further investigation.—Interference fringes shown by colour photographs: E. **Rothé.**—A repeating auto-ballistic galvanometer: A. **Guillet.** If successive small impulses are imparted to the ballistic needle at periods corresponding to its vibration period, a large increase of sensibility results. An automatic arrangement for effecting this is described in the present paper.—Dynamos without a collector: C. **Limb.** The application of electrolytic values to dynamos.—The stability of the alternating arc as a function of the atomic weight of the metals forming the electrodes: C. E. **Guye** and A. **Bron.**—The orientation of crystals by the magnetic field. The importance of the optical properties of mixed liquids from the point of view of crystalline symmetry: A. **Cotton** and H. **Mouton.**—The phenomena of Bose and the laws of contact electrification: Édouard **Guillaume.**—The Bose-Guillaume phenomenon and contact electrification: Jean **Perrin.**—A relation between the magnetic and chemical properties of complex iron salts: P. **Pascal.**—The total heats of baryta, witherite, and fused lime: M. **Latschenko.**—The development of negatives in radiography: Maxime **Ménard.** A description of the modification in the details visible in the negative which can be produced by variations in the method of working with the same developing bath.—The influence of the medium on the Brownian movements: Victor **Henri.** A quantitative study by means of a kinematograph microscope of the effects produced by the addition of various amounts of acids and alkalis to the latex of india-rubber. A new iodide of titanium, titanous oxide, $TiI_2$: Ed. **Defacqz** and H. **Copaux.** The new iodide is obtained by the action of mercury vapour upon $TiI_4$ in an atmosphere of hydrogen at a red heat.—The heat of neutralisation of picric acid by various aromatic bases in benzene solution: Léo **Vignon** and M. **Evieux.** Picric acid differs from acetic and benzoic acids in that it forms salts readily with aromatic bases in benzene solution. It furnishes examples of formation of salts in the absence of ionisation.—The direct transformation of borneol into campholic and isocampholic acids: Marcel **Guerbet.** If borneol is heated in sealed tubes at 250° to 280° with recently fused potash it is almost quantitatively converted into the potassium salts of campholic and *iso*campholic acids, hydrogen being evolved.—The preparation of benzoylacetic esters: A. **Wahl.** By the action of sodium upon an ethereal solution of ethyl benzoate, benzoin is produced. Hence, in the condensation of ethyl acetate and benzoate with sodium, three distinct reactions are produced.—Ergosterin and fongosterin: C. **Tanret.**—Study of the *rôle* of yeasts in the aldehydification of alcohol: MM. **Trillat** and **Sauton.**—The influence of formic acid vapours on the growth of *Rhizopus nigricans*: Henri **Coupin.**—The recollection of the tides in *Convoluta Roscoffensis* and its alteration: Louis **Martin.**—The structure of the renal cell: L. **Bruntz.**—The first venous circulation of *Carassius auratus*: P. **Wintrebert.**—Study of the immunising action of chlorinated derivatives of bacilli: MM. **Moussu** and **Goupil.**—The quaternary alluvium of the Loire and Allier: E. **Chaput.**

### New South Wales.

**Linnean Society,** May 27.—Mr. J. H. Maiden, vice-president, in the chair.—The behaviour of *Hyla aurea* to strychnine: Dr. H. G. **Chapman.** The common Australian frog *Hyla aurea* has been noted not infrequently to be much less susceptible to the poisonous alkaloid strychnine than European frogs of the genus Rana. The minimal lethal dose for various species of Rana has been measured by numerous observers, and there seems to be general agreement that it may be said to lie between 2 mg. and 5·5 mg. per kilogram of body-weight. For *Hyla aurea* the minimal lethal dose is 0·1 mg. per gram of body-weight, and is somewhat higher in frogs collected in winter than in those collected in summer, but is unaffected by differences in sex. The receptive substance of the muscles of *Hyla aurea* is sensitive to strychnine, so that the frogs show, with appropriate doses, typical curare paralysis. The prominence of this action produces a characteristic type of poisoning in Hyla.—Notes from the Botanic Gardens, Sydney, No. 13: J. H. **Maiden** and E. **Betche.** The authors described several new species, new varieties, new records for New South Wales, and new localities, and made some remarks on notable plants.—A contribution to our knowledge of Australian Hirudinea. Part i.: E. J. **Goddard.**

### Calcutta.

**Asiatic Society of Bengal,** June 3.—Tibetan charms obtained by Lieut.-Colonel S. H. Godfrey in Ladakh, one for chasing away evil spirits and the other for compelling fortune: Dr. S. C. **Vidyabhusana.** These two charms are printed from wood blocks, and used by people of Ladakh who are entirely ignorant of the meaning of the writing on them. The writing is Sanskrit in Tibetan characters.—A polyglot list of birds in Manchu, Chinese, and Turki: Dr. E. D. **Ross.**—Materials for a flora of the Malay Peninsula, part No. 21: Sir George **King** and J. S. **Gamble.** The part contains the two families which complete the Gamopetalæ, viz. No. 86, Gesneraceæ, and No. 90, Verbenaceæ. A review of the former of these families was published in 1905 by Mr. H. N. Ridley, director of the Singapore Botanic Garden, in the Journal of the Straits Branch of the Royal Asiatic Society, but as the form of that publication was not quite the same as has been used by Sir G. King and his various helpers, Mr. Ridley's work has been revised by Mr. Gamble with the help of Lieut.-Colonel D. Prain, of Kew. The Verbenaceæ have been worked up by Mr. Gamble. Part No. 21 also contains the addenda and corrigenda of the Gamopetalæ and the index to vol. lxxiv.—Note on the peregrine falcon (*Falco peregrinus*): Lieut.-Colonel D. C. **Phillott.**—The use of the abacus in ancient India: E. R. **Kaye.** Tylor, Woepcke, Rodel, Burnell, Bayley, and other writers on Indian mathematics assume that the abacus was in common use in ancient India, but they give no evidence of such use. They, however, on this assumption build up elaborate arguments to prove that our arithmetical notation was invented in India, and incidentally that the Arabs owe their arithmetic to the Hindus. An examination of their statements shows that their assumption is unwarranted, and, indeed, that no evidence at all has yet been given of the use of this instrument in ancient India. This, of course, does not prove that the abacus was not used by the early Hindus, and it is with the idea of eliciting evidence on this point, if it exists, that this paper was read.—Plea for an aquarium in Bengal: Rai Ram Brahma **Sanyal.** The author advocates the establishment of an aquarium at Puri, chiefly for the study of economic questions regarding the fisheries of the Bay of Bengal.—A descriptive list of works on the Madhyamika philosophy: Dr. S. C. **Vidyabhusana.** This paper gives a short account of the Tibetan versions of twenty-seven works on the Madhyamika philosophy, the Sanskrit originals of which, with one exception, appear to have long been lost. The Tibetan versions are included in the well-known collection called the Tangyur, which the writer of the paper examined while residing at the monastery of Labrang, in Sikkim, in June, 1907. They include the works of Arya Nagarjuna, Arya Deva, and Buddha Palita, besides those of the teacher Bhavya, who criticised the contemporaneous systems of Hindu philosophy, viz. the Yoga, Samkhya, Vaisesika, Vedanta, and Mimamsa. These works, which have not been noticed elsewhere, are very important, as they throw a good deal of light on the history of Indian philosophy.—The mechanical, physical, and chemical theories of the ancient Hindus, part i.: Principal B. N. **Seal.** A synoptic view of the mechanical, physical, and chemical theories of the ancient Hindus, based chiefly on the Vyasa Bhashya or Patanjali's Sutras, the Samhita of Charaka, the Bhashya of Prasastapada, the Vartika of Udyotakara, and the Vrihat Samhita of Varaha Mihira, which belonged to the fourth, fifth, and sixth centuries of the Christian era.—Geometrical theory of a plane non-cyclic arc, finite, as well as infinitesimal: Prof. S. **Mukhopadhyaya.**—A memoir on the surgical instruments of the Hindus, with a comparative study of the instruments of Greek, Roman, Arab, and modern European surgeons, part i.: Dr. G. N. **Mukhopadhyaya.** The author describes the surgical instruments of the Hindus, and concludes that knowledge of the kind was considerably more advanced among them than previously held to be.—Rationalisation of algebraical equations: Mahendranath **De.**



## CONTENTS.

THURSDAY, JULY 23, 1908.

## PATENTS AND THE PUBLIC.

*The Patents and Designs Act*, 1907. By James Roberts and H. Fletcher Moulton. Pp. xiv+128. (London: Butterworth and Co., 1907.) Price 4s. net.

IN the preface to this book the authors state that it does not pretend to be a treatise on patent law, but that its object is to give assistance to the reader in the interpretation of the new enactments and to point out their practical effects. The authors have not discussed the wisdom of the many changes in the law introduced by the new Act, nor have they attempted to dogmatise on points which must necessarily, on account of the language employed in framing the new provisions, await judicial decision. They have, however, indicated where these points lie, and have directed attention to both aspects of the questions involved so as to enable persons dealing with patents to appreciate the dangers ahead.

Among the many changes to which the authors direct attention are the important alterations in the jurisdiction and powers of the Comptroller. The jurisdiction of the Comptroller as to the granting of patents has been extended by giving him the power, under section 7, to refuse a patent altogether if he is satisfied that the invention claimed has been wholly and specifically claimed in any specification published before the date of the application for the patent in question. In cases of opposition under the Act of 1883, the Comptroller had power to refuse to grant a patent if the invention had already been patented in this country, and the new Act extends this practice in opposition cases to cases coming under the official search instituted by the Act of 1902. The words "wholly and specifically claimed" would appear to indicate that it is intended to give the Comptroller power to refuse under this provision only patents for those inventions which have been described and claimed in prior specifications in substantially identical terms. This new power of the Comptroller should prove to be of considerable benefit to the i[illegible]al community in that it will tend to prevent the [illegible] of worthless patents, of which there are such a large number in existence.

The jurisdiction of the Comptroller as to the granting of patents has been also extended by enlarging the grounds of opposition before him, for by section 11 any person may give notice of opposition on the ground that the nature of the invention or the manner in which it is to be performed is not sufficiently or fairly described and ascertained in the complete specification. Hitherto it has been the practice that a member of the public who had no special interest was not entitled to oppose the grant of a patent, but the question of what persons are entitled to be heard in opposition now becomes of greater importance, as it is only such persons as are entitled to oppose under this section who are entitled to petition for the revocation of the patent under section 26. The two distinct views which may reasonably be taken of the right to oppose under this section are fairly stated by the authors, but it is not at present clear which view will finally be adopted. This section should result in a desirable improvement of the descriptions contained in specifications, for unless the nature of the invention and the manner in which it is to be performed are sufficiently and fairly described and ascertained in the complete specification, this may be made a ground of opposition to the grant.

Two important changes in the practice of developing an invention are introduced by the new Act. Under section 16, an applicant who has put in two or more provisional specifications for inventions which are cognate or modifications one of the other may file one complete specification in respect of the whole of the applications, so that by this section an applicant may, as the authors state, "file several provisional specifications as improvements occur to him, and in the event of the Comptroller allowing them to be included in one patent, he does not risk invalidity by reason of disconformity." Under section 19 a patent of addition may be applied for in respect of any improvement in or modification of the invention for which an ordinary patent has been applied for. The advantage of introducing patents of addition is that they enable a patentee to develop his invention at less cost than would be incurred by taking out separate patents for each improvement, as no renewal fees are payable in respect of a patent of addition.

The practice on a petition for revocation of a patent has been very much altered by the new Act. Revocation of a patent may be obtained on petition to the Court as hitherto, but, in addition, the Comptroller may now revoke a patent on various grounds. In the first place, under section 26, any person who would have been entitled to oppose the grant of a patent may, within two years of the date of the patent, apply to the Comptroller for an order revoking the patent on any ground on which the grant might have been opposed; so that under this section an opponent may come in to petition for revocation, and thus subject the patentee to the annoyance of what is practically an opposition considerably after the time has expired in which an opposition could have been entered under the old procedure. Secondly, under section 27 any person may apply to the Comptroller for the revocation of a patent on the ground that the patented article or process is manufactured or carried on exclusively or mainly outside the United Kingdom. The authors state that:—

"An attempt was made to attain the object of this clause by section 3 of the Act of 1902, but that section has proved practically a dead letter, partly in consequence of its ambiguity and partly because of the heavy expense it entailed on a petitioner. In the year 1906, out of 14,700 patents issued, 6500 were granted to foreigners; in the case of patents for dyes the proportion was about 95 per cent. In many cases these inventions were worked abroad exclusively, and the patented articles, or substances made by the patented processes, were imported in large quantities into this country, the British patents being used merely for the purpose of closing the market to persons other than the patentee and his licencees."

Such a state of affairs was in direct opposition to the spirit of our patent law, and as the obvious remedy of forfeiture of the patent, on account of the importation, under which the imported articles were made was prohibited by the fifth article of the International Convention, section 27 was introduced to meet the difficulty. By this section, which will come into operation on August 28, the Comptroller will have to consider the application for revocation, and if after inquiry he is satisfied that the allegations contained in it are correct, and unless the patentee proves that the patented article or process is manufactured or carried on to an adequate extent in the United Kingdom, or gives satisfactory reasons why the article or process is not so manufactured or carried on, the Comptroller may make an order revoking the patent either forthwith or after a reasonable interval.

Much has been written lately as to the benefits to this country likely to be produced by this section, and in some cases there has been considerable exaggeration of the probable effects. But although it is almost impossible to state accurately the effects of the section until it is discussed in actual practice, there is no doubt of the fact that foreign inventors are now showing a greater desire than ever before to have their patents worked in the United Kingdom. In and about London, for instance, sites are being acquired for the erection of factories for the manufacture of articles patented by foreign inventors, while in Leicester the manufacture of machinery for making boots and shoes is being largely extended, and a factory has been leased for the manufacture of safety razors. The advertisement pages of the trade journals and of the illustrated official journal of the Patent Office also indicate the anxiety of many foreign inventors to have their patents worked in the United Kingdom in order to avoid revocation.

Perhaps the most interesting case under this section may prove to be the case of the German chemical industries. It is well known, of course, that although the inventor of the original artificial dye was Perkin, the aniline dye trade has been transferred almost entirely to Germany, the proportion of patents in dye cases granted to foreigners being in 1906 about 95 per cent. Most of these patents are under the control of a few large syndicates, and at least one of these syndicates is making active preparation for working their patents in this country. The extent to which this working will be insisted on is, at present, quite problematical, as, under the section, the Comptroller need make no order revoking the patent if the patentee gives satisfactory reasons why the article or process is not manufactured or carried on in this country. What is a satisfactory reason? Is it a satisfactory reason that the article or process can be manufactured or carried on more cheaply abroad? Is it a satisfactory reason to have advertised for someone to work the patent and to have received no offer? These and many other questions at once arise and present difficulties which can, apparently, be settled only in practice.

The authors deal with the many minor changes in the law introduced by the new Act, and, although the comments might with advantage have been more lavish, the book may be recommended as a clear and concise discussion of the new enactments.

## A HISTORY OF GEOGRAPHICAL EVOLUTION.

*Die Entwicklung der Kontinente und Ihrer Lebewelt ein Beitrag zur vergleichenden Erdgeschichte.* By Dr. T. Arlt. Pp. xviii+730. (Leipzig: W. Engelmann, 1907.) Price 20 marks.

THE explanation of the obvious plan in the distribution of oceans and continents has long been one of the ideals of geography. Bacon insisted that one of the main duties of geographers was to solve the riddle of the geographical homologies, and at length a solution has been advanced that has made widespread progress into favour during recent years—the daring and once ridiculed tetrahedral theory of Lowthian Green. That theory, simply stated, is that hard-shelled spheroidal bodies that are contracting owing to internal shrinkage tend to become flattened on four faces; that the spheroid undergoes a tetrahedral deformation as the unshrinkable shell sags down after the contracting interior, and that this shape develops as the body thus most easily gets rid of the excess of surface. The extent of this deformation is limited in a revolving mass, as the effects of rotation oppose the deformation and tend to restore the spheroidal form. Modern developments of the tetrahedral theory attribute to this struggle between tetrahedral collapse and spheroidal recovery an alternate advance and retreat of the sea upon the land, as the ocean basins are alternately deepened and shallowed; and the occurrence of epochs of intense volcanic activity, following long intervals of quiescence, is attributed to disturbances that restore stability to the earth after a period of slow deformation has rendered the crust unstable.

The ultimate test of this theory is its agreement with the records of historical geology, and that test Dr. Arlt applies to it in the large volume of some 730 pages and an atlas of twenty-three plates. The author marshals a very varied array of evidence collected from geography, stratigraphical geology, palæontology, and geodesy. Dr. Arlt shows he has studied an enormous and varied literature, and is capable of handling petrographical, biological, and mathematical evidence.

The book begins with a brief reference to the theory of the permanence of ocean and continent which was much in vogue from 1876 to 1890. If that theory be true, the tetrahedral theory is unnecessary; for one of the astronomical theories which attribute the distribution of the continents to agencies that affected the earth in pre-geological times might be adequate. But, as Prof. G. H. Carpenter has recently remarked, "there can be no doubt that the trend of modern speculation is against the doctrine of the permanence through past ages of the great ocean basins of the present day" ("Scottish National Antarctic Expedition, Report on Scientific Results," vol. v., p. 57); and in accordance with most recent work, Dr. Arlt shortly and emphatically dismisses the theory as inconsistent with the facts. He then proceeds to state the methods of palæogeography They are the petrographic—the study of sedimentary rocks and deep-sea deposits—and the biological—the study of the existing and former distributions of animals and plants.

In the biological section the author deals mostly with the land faunas and floras; for their evidence is naturally the most significant regarding former land connections. But the marine fauna also gives weighty evidence. The writer pointed out in 1891 that the relations of the echinoid faunas of North America and Europe gave convincing evidence of a middle Cainozoic land connection across the Atlantic; and the position then indicated for the North Atlantic shores from the migrations of the sea urchins corresponds to the general position assigned to it by Dr. Arlt from the migrations of land animals. In his statement of the biogeographical evidence, Dr. Arlt follows the method of Blanford's fine address to the Geological Society in 1890. He considers the existing distribution of each group of land organisms in connection with its geological history and with the probable distribution of land and water on the earth during its development. He illustrates the land routes available for migration at successive periods in the history of a group by an ingenious series of diagrams (*e.g.* plate ii.). Dr. Arlt devotes 300 pages to a summary of our knowledge as to the geographical distribution of Cainozoic life. For the existing biological regions he adopts the division into three, and the names he uses suggest the age of the faunas and floras that inhabit them. The Holarctic region he names Kainogæa, on account of the modern character of its life; the Ethiopian and Oriental regions he groups together as Mesogæa; and for the remaining regions, including Australasia, Madagascar, and the Neotropical region, he adopts, with a modified meaning, Dr. Sclater's name, Palæogæa, as the region is characterised by ancient life.

The author then deals similarly with the distribution of Mesozoic and Palæozoic life, and the former continental unions thus proved. He quotes widely from literature, and numerous references show his indebtedness to the works of Lydekker.

The second main division of the work is geological, and here the author is largely dependent upon the work of Suess. He summarises the evidence from the various former continents, including North Atlantis, South Atlantis, Angaraland, Gondwanaland, the larger Oceania and Antarctica. He then describes the seven chief Archæan massifs, the ancient coigns of the earth, which have remained unbroken since the earliest geological times, and have guided the course of the earth-folds that formed the chief fold-mountain lines of the earth.

The section on historical geology summarises the chief geographical incidents and the characters of the life of each of the geological systems, and insists on the periodicity in the dominant phenomena. The author's conclusions, though probably right in the main, perhaps overstate the regularity of the periodicity. For instance, he divides known geological history into six cycles—the Cainozoic-Mesozoic, Upper Palæozoic, Middle Palæozoic (Lower Devonian and Silurian), Lower Palæozoic (Ordovician and Cambrian—the author, however, does not adopt the former term), the Algonkian, and the Urschiefer. Each cycle he represents as beginning with a marine transgression, followed by a period of fold-mountain formation, and then by vast eruptions of basic volcanic rocks, and each cycle closes with a Glacial period. He accepts six Glacial ages, viz. one in the lower and one at the top of the Algonkian, and others in the Upper Ordovician, Lower Devonian, Permian, and Pleistocene. The evidence for these six glaciations is not yet convincing.

Dr. Arlt traces, too, in the last pages of his work the influence of the former land distribution on the distribution of human races. He assigns the original home of mankind to the area north of the Himalaya. As land distribution at the arrival of man was in broad outlines essentially the same as now, the migrations of man, as is shown in the last of Dr. Arlt's admirable series of charts, followed the existing land lines. The woolly-haired races spread from Southern Asia into Africa and Melanesia; the stiff-haired Malays crossed oversea from Malaysia to Madagascar and the islands of the Western Pacific (the author unfortunately includes the Maoris as Malays), and the allied Mongols occupied northern Eurasia and America. The members of the author's last group, including the Indo-Germanic, Semitic and Hamitic peoples, and Dravidians, Veddas and Australians, overran southern Europe and northern Africa, while one section of it passed through the Malay Archipelago to Australia.

Dr. Arlt's work is extensive, comprehensive—the index occupies ninety-eight pages—and ambitious. Probably not one of his readers will agree with it all. The chapters are necessarily of unequal value. Among his classifications of animals, *e.g.*, that of the Echinoderms on his phylogenetic chart of that group, he adopts a now out-of-date system from von Zittel's textbook of 1883. But the work is of great value; it is original, suggestive, and, taken as a whole, we think sound. It is the fullest statement yet issued of the doctrines of a school of geological thought which appears to be making steady progress, and it shows the necessity for the combined study of palæontology, geology, and petrography in discovery of the actual history of the geography of our earth.

J. W. GREGORY.

## BOTANY ON THE VOYAGE OF THE "VALDIVIA."

*Wissenschaftliche Ergebnisse der deutschen Tiefsee-Expedition auf dem Dampfer "Valdivia," 1898–1899.* Edited by Prof. C. Chun. Vol. ii., Part i., No. 2, Beiträge zur Kenntniss der Vegetation der Canarischen Inseln. By H. Schenck. Pp. 180; with 12 plates. Price 45 marks. Vol. ii., Part ii., No. 3. Das Indische Phytoplankton. By G. Karsten. Pp. 326; with 25 plates. Price 70 marks. (Jena: Gustav Fischer, 1907.)

THE second volume of these memoirs has been assigned to the botanical results of the *Valdivia* expedition. The first part deals with insular floras, the second with marine floras, and there will be an account of plants collected in countries visited on the mainland. Dr. H. Schenck is responsible for the account of the Canary Islands, as he was for the previous numbers referring to the islands of Kerguelen, St. Paul, and New Amsterdam; but much of the text and a few of the illustrations are again the work of the late Prof. A. F. W. Schimper, who was botanist to the expedition. The character sketches written by Prof. Schimper bear that particularly vivid impress and breadth of view that characterise "Die Pflanzengeographie." Certainly he has a most fascinating subject, as the flora of the islands is rich in curious endemic plants.

The zones of vegetation as developed on the island of Teneriffe are fairly typical for the group. Schimper distinguishes three regions, basal, montane, and alpine. The basal region is the most extensive; here are found the weird arboreal monarch of the island, *Dracaena Draco*, the dragon's blood tree, showing at first an unbranched stem with tiers of horizontal leaves, but developing later a much-branched system; the candelabra-like *Euphorbia canariensis* and a date palm, *Phoenix Jubae*, the fruits of which provide food for birds but not for man. These are the dominant endemic species, but there are many others, succulent species of Euphorbia, Ceropegia, Echium, &c., and xerophytes characterised by a mass of thin, whip-like branches and narrow leaves, of which *Plocama pendula* furnishes a type. The proportion of endemics in the coastal vegetation is about one-third, a large number being species of Statice.

In the montane region Schimper notes particularly the laurel forest, where *Laurus canariensis*, *Erica arborea*, *Ilex canariensis*, and *Ocotea bullata* hold sway. Great interest attaches to several of these, because they are evidently closely connected with Tertiary fossil forms found in European countries. *Pinus canariensis* gives character to the landscape at 5000 feet, while higher *Spartocytisus supranubius* is almost the sole occupant of the black, stoney slopes. The volume is altogether *un embarras de richesse*, with copious illustrations, some in heliogravure, others interspersed with the text. Not the least pleasing feature is the generous manner in which Dr. Schenck has subordinated his work to that of his former colleague.

The study of phytoplankton is, for obvious reasons, a more exclusive subject, but the results given in the two volumes of text and plates are full of interest. Two earlier accounts treated of the gatherings taken in the Antarctic and Atlantic, while the plankton of the Indian Ocean is here under discussion. It was found that a definite limit to the Antarctic region could be set at Kerguelen Island. As the ship proceeded northwards the character of the plankton changed, species of Ceratium and Peridineæ generally becoming more numerous. Off Sumatra an increase of diatoms and Schizophyceæ connected with the increased food supply furnished evidence of coastal plankton mixed with the oceanic forms. Respecting vertical distribution, it was noted that in tropical waters the mass of plankton exists in the upper six hundred feet, while at twelve hundred feet living forms practically cease. The morphological details at the end of the volume include notes on diatom microspores, the formation of the rays in certain of the Peridineæ, and some life-histories. A final word of commendation must be bestowed on the volume of exceptionally fine drawings that have been skilfully reproduced.

## SOME NEW CHEMICAL BOOKS.

(1) *A Systematic Introduction to Analytical Chemistry.* By A. F. Walden and B. Lambert. Pp. vi+176. (Oxford: J. Thornton and Son, 1908.) Price 3s. 6d.

(2) *Naturlehre für höhere Lehranstalten.* I. Teil. Chemie, Mineralogie, und Geologie. By Dr. F. Dannemann. Pp. viii+225. (Hanover and Leipzig: Hahnsche Buchhandlung, 1908.) Price 2.80 marks.

(3) *Organic Chemistry.* Including certain portions of Physical Chemistry for Medical, Pharmaceutical, and Biological Students. By H. D. Haskins and J. J. R. Macleod. Pp. xi+367. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd., 1907.) Price 8s. 6d. net.

(4) *Stereochemie, die Lehre von der Räumlichen Anordnung der Atome im Molekül.* By Dr. L. Mamlock. Pp. vi+152. (Leipzig: B. G. Teubner, 1907.) Price 5 marks.

(1) ALTHOUGH there is perhaps no branch of chemistry which at the present day is more stagnant than analysis (of the academic as distinguished from the technical kind), there are always to be found teachers whose interest in the subject will prompt them to publish their experiences. With this interest we have the greatest sympathy, for there is no doubt that the skill, neatness, intelligence and patience which analysis demands will always appeal to the chemist. Analysis is, in fact, his handicraft, just as much as the using of a lathe or a planing machine is that of the mechanical engineer, with this difference: that whilst the engineer may employ a mechanic to do his practical work, the chemist must always be his own analyst.

When we approach the question of the place of analysis in chemical teaching, we put the subject at once on a different plane and see it in a different perspective, for as students of chemistry are not all to be professional chemists, we have to consider analysis as merely a part of chemical teaching. There is no doubt that there has been a tendency for the subject to assume an exaggerated value. We inherited the tradition of the Stockholm Laboratory, and continued it because it adapted itself to practical examinations in chemistry. We do not believe any more than the authors "that the neglect of qualitative analysis is either necessary or desirable," but there is a great difference between learning the principles of the process and studying it as a part of the technique of the professional chemist. For the ordinary student there seems no object in discovering and identifying such uncommon combinations as meta- and pyro-phosphoric acid, fluosilicates or perchlorates. The range of practical chemistry has so increased of late that it has become more than ever imperative to restrict the study of one branch if it encroaches on the time which could be given more usefully to another. As to the general character of the book under review, we have failed to discover anything very original in its treatment of the subject, but it seems to be a thoroughly safe and trustworthy guide.

(2) This volume (the first of two parts) is for use in Realschulen and Gymnasien. It is divided into sections. There is one on descriptive and practical chemistry which covers 100 pages, including ten pages on technical processes, one of forty pages on mineralogy, including eight on crystallography. There are about thirteen pages on geology, three pages describe experiments on vegetable physiology, and the last forty pages are devoted to object lessons on topics which range from Scheele's discovery of oxygen to the growth of coral islands. The book is well printed on good paper, illustrated by excellent drawings, and compiled with evident care. It is also, in a sense, a practical manual, the first section being interspersed with a variety of simple chemical experiments. Yet in spite of its attractive appearance it is a satisfaction to think that such a book would find no place in any school in this country. Its defect is diffuseness, especially in the latter sections. We can form a pretty clear notion of the effect of a course of this kind on an average boy or girl. They would have absorbed a number of scientific names, have formed a hurried acquaintance with different kinds of apparatus, remembered several chemical formulæ; they would describe the six crystallographic systems, and talk about sedimentary and igneous rocks; but their knowledge would be a kaleidoscopic assortment of ideas which could produce no sharp and permanent impression, and would do little to stimulate a living interest in the things about them.

Whatever shortcomings our systems of science teaching may possess, we do not set schoolboys and girls, who are old enough to study science seriously, to nibble at a scientific scrap-heap. They may do that as much as they please out of school, and perhaps the more they do it the better; but in school the process with older children must be methodical and thorough, and not superficial and diffuse, and should leave the boy or girl with a solid foundation to build upon.

(3) The authors state in their preface that "it was with the idea of presenting in the simplest manner the facts of organic and physical chemistry which have an essential bearing on medical science that the present work was written." There is no doubt that in the present state of organic chemistry a process of judicious selection for special needs is not only desirable, but imperative. Like the botanist, one has to transplant typical specimens into trim little beds where they can be examined individually without the brain becoming bewildered by an endless and varied flora. Thus the authors have emphasised those facts which have a special relation to physiology and pharmacy, and have suppressed matter which they consider of less importance, and have done it with considerable judgment. Whether they have succeeded as well with the few brief references to physical chemistry is doubtful, the space allotted being altogether inadequate for even an elementary exposition of the subject.

We would direct the authors' attention to the following errors which have been noted in glancing through the book. Amyl and ethyl nitrite are not usually described as "nitro" compounds (p. 162); no distinction is drawn between the metallic derivatives of glycol and glycollic acid, both being described as *glycolates* (pp. 142 and 166); racemic lactic acid is not indicated by "*i*," but by "*r*" (p. 169); *nitrobenzlidene* is wrongly spelt (p. 195); *purine* is not the atomic framework, but the mother-substance of the uric acid group (p. 204); there is a step missing in Traube's synthesis of uric acid (p. 201); and the formula for safrole is wrong (p. 316).

(4) This book is intended for those who are not professed chemists, but are interested in the related sciences of physics and chemistry. It is a clear and concise exposition of the subject, a sort of abridged Werner's "Lehrbuch," and will no doubt fulfil the purpose for which it was compiled. Satisfactory as the book is in many of its essential features, it reveals a curious ignorance on the part of its author of much of the recent work on stereochemistry published in this country. We have noted the following more important omissions. There is no reference to McKenzie's researches on asymmetric synthesis, or to Patterson's work on the activity of substances in solution, or to his recent paper on "Optical Superposition," or to Kipping's synthesis of optically active silicon compounds. A book which ignores, whether by accident or design, contemporary research cannot be regarded as an entirely trustworthy guide. J. B. C.

## OUR BOOK SHELF.

*The Animal Mind. A Text-book of Comparative Psychology.* By Dr. Margaret Floy Washburn. Pp. xi+333. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1908.) Price 7s. net.

This book is the second volume of a series to be devoted to animal psychology, under the title of "The Animal Behaviour Series." The first volume—"The Dancing Mouse," by Dr. Yerkes, recently reviewed in these pages—was an exposition of the different experimental methods applicable to the investigation of the psychology of one particular animal. Miss Washburn's book likewise follows the experimental method, and aims at presenting concisely the facts and principles that have emerged as the result of the application of this method during the last ten or twenty years to the study of different forms of animal behaviour.

Starting with a general statement of the difficulties and limitations inherent in the science of comparative psychology, the author proceeds to give a somewhat brief yet penetrating and concise discussion of the problem of inferring mind from structure and function respectively. Miss Washburn's conclusion is so typical of her general attitude throughout the book that it may well be quoted here:—"We can say neither what amount of resemblance in structure to human beings, nor what speed of learning constitutes a definite mark distinguishing animals with minds from those without minds, unless we are prepared to assert that only animals which learn so fast that they must have memory ideas possess mind at all. And this would conflict with the argument from structure. For example, there is no good experimental evidence that cats possess ideas, yet there is enough analogy between their nervous systems and our own to make it improbable that consciousness, so complex and highly developed in us, is in them wholly lacking."

There follows on this a very full and admirably lucid description of the investigation of sensory discrimination, space perception, and higher forms of consciousness in the various classes and orders of the animal kingdom—methods and results being in every case given in connection with the names of the investigators and references to their works. These references, by the way, nearly five hundred in number, are collected at the end of the book, under the heading "Bibliography," and greatly enhance the value of the book to the intending research student.

Two chapters are devoted to the consideration of the processes of learning in animals. The subject is as difficult as it is important, which perhaps justifies the author's attitude of extreme caution, apparent throughout the discussion. The account is descriptive rather than critical. For example, the conflict between the results of Thorndike and Hobhouse respectively in their experiments on cats and dogs is indeed stated but not discussed. The closing chapters on the memory idea and attention are full of interest, and really come to close quarters with the vexed question of the relation of animal to human intellect.

Psychologists will be unanimous in their gratitude to Miss Washburn for the very thorough way in which she has accomplished her task.

WILLIAM BROWN.

*Natur-Urkunden.* By Georg E. F. Schulz. Heft 1. Vögel. Erste Reihe. Pp. 20, with 20 plates. Heft 2. Planzen. Erste Reihe. Pp. 16, with 20 plates. Heft 3. Planzen. Zweite Reihe. Pp. 16, with 20 plates. Heft 4. Pilze. Erste Reihe. Pp. 16, with 20 plates. (Berlin: Paul Parey, 1908.) Price 1 mark for each part.

VARIOUS books on birds by Messrs. Kearton, and others on natural history, including a miniature series that has attained a wide circulation, have served to indicate how suitably photographs from the life may be utilised to illustrate books on botany and zoology. A very charming series of this kind is now being issued by Messrs. Paul Parey under the title of "Nature Records"; they are being entirely prepared as to photographs and text by Mr. G. E. F. Schulz. The volumes will deal with both branches of natural history. Of the first four, two are devoted to wild plants and a third to fungi. It will be recognised that, owing to their low growing position, size, and tendency to movement, it requires great care and skill to photograph plants as they grow. However, Mr. Schulz is not content to take his photographs under the easiest conditions, but has been at considerable pains to record special phases, such as the open flowers of *Silene noctiflora* and the rain-flecked leaves of *Aira canescens.* Among the illustrations of fungi, one of the best, representing *Boletus scaber,* shows even part of the hymenophore.

Difficult as it must have been to secure these plant photographs, some of the studies of birds in the first part must have required even greater skill and patience. There is a delightful picture of the parent tern holding a small fish while one youngster tries to gobble and the other cries lustily. The turning of the eggs in the nest is shown both for the seagull and the avocet. Altogether the volumes cannot fail to meet with the admiration of all "nature-lovers." Inasmuch as the records are taken at random, the series is intended primarily for the *dilettante,* but the author's notes are full of nature knowledge that may be recommended to teachers of nature-study and others who are not too old to learn. It is to be hoped that the early parts will have a ready sale, as in these circumstances the series will be continued.

*A Pocket Handbook of Minerals.* By G. Montague Butler. Pp. ix+298. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1908.) Price 12*s.* 6*d.* net.

EVERY student of mineralogy knows how difficult it is to acquire facility in identifying minerals off-hand. It is with the view of assisting the student, the miner, and the collector in determining his specimens that this little work has been prepared. It has no pretension to be a manual of mineralogy, even of an elementary character, but it is simply a book for the pocket, to be used as a work of ready reference. For this purpose it seems well adapted. The mineralogist finding an unknown or doubtful mineral may turn to it for assistance, much in the same way that a botanist would use his flora. Chemical and crystallographic characters are deposed from the supreme position which they usually occupy, and attention is directed rather to obvious physical characters, which in some cases appear even trivial, but are yet of diagnostic value. The most characteristic features of a mineral are emphasised by being printed in thick type so as to catch the eye. At the end is a rather ingenious scheme, forming a kind of artificial key for the identification of an unknown species. There is also a glossary, which seems to have been prepared with care.

As the book is likely to be used by the prospector, the commercial element is not ignored, and tables are introduced giving the value of metals, useful minerals, and especially gem-stones. It is notable that space for notes is left here and there in the book, a feature which, though increasing the size of the volume, is likely to be of service in the field; thus a description of moonstone in less than half-a-dozen lines occupies an entire page (p. 136). We have not noticed many printer's errors, but the name of the mineralogist who suggested the scale of hardness was Mohs, not Moh, as printed twice on p. 290.

*La Lutte contre les Microbes.* By Dr. Etienne Burnet. Pp. ix+318. (Paris: Librairie Armand Colin, 1908.) Price 3.50 francs.

IN this book a very readable account is given of certain diseases of microbic origin, of the parasites producing them, modes of transmission, and methods of treatment and prevention. Cancer is first dealt with, the author evidently inclining to the view that this disease is due to a micro-parasite, transmitted perhaps by food and by insect parasities, which we think is probably not the case. The statistical part of this section is a useful summary of data concerning the frequency of the disease, cancer houses and districts, &c. After cancer, tuberculosis, tetanus, sleeping sickness, intestinal infections, and small-pox and vaccinia are dealt with, and with these the author is on less debatable ground, and a good summary of our knowledge of each is given. The volume concludes with a translation of Jenner's researches on the causes and effects of cow-pox.

R. T. HEWLETT.

*The Farm shown to the Children by F. M. B. and A. H. Blaikie.* Described by Foster Meadow. Pp. xii+91. (London and Edinburgh: T. C. and E. C. Jack.) Price 2*s.* 6*d.* net.

THIS attractive little volume contains a great deal of information about farming, expressed in a very simple manner. Its forty-eight coloured pictures are sure to please children greatly, and the book, as a whole, is well calculated to arouse an interest in agricultural pursuits.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### The Nature of the $\gamma$ and X-Rays.

IN a previous letter to NATURE (January 23, p. 270) I gave a brief description of some experiments made by Dr. Madsen and myself on the properties of the secondary radiation due to $\gamma$ rays. A fuller account is given in the Transactions of the Royal Society of South Australia, 1908, p. 1.

The experiments have been continued, and I hope that the following summary of the results will be of interest:—

(1) When $\gamma$ radiation is diminished in quantity as it passes through matter, $\beta$ radiation appears in its place, moving at the outset in the original direction of the $\gamma$ radiation, and subsequently undergoing scattering in the ordinary manner of $\beta$ rays.

(2) The penetration and therefore the speed of the $\beta$ radiation thus produced increases with the penetration of the $\gamma$ radiation to which it is due.

(3) The speed of the $\beta$ radiation does not depend upon the nature of the atom in which it arises.

(4) In the case of radium at least, the speed of the $\beta$ radiation is nearly equal to, perhaps a little less than, the speed of the normal $\beta$ rays emitted by radium itself.

(5) When very hard $\gamma$ rays traverse matter their absorption and therefore the production of $\beta$ rays are almost independent of the atomic structure of the matter, and a density law follows. Softer rays are affected by atomic structure; they are more absorbed by heavy atoms than by light atoms for equal weights of absorbing screen. The softer the rays, the greater is this effect. Hence arises the difference in character of the logarithmic curves of absorption of different substances; heavy atoms show a rapid initial fall. Hence also when soft $\gamma$ rays are used the emergence radiation from heavy atoms may be greater than from light atoms. And again, the relative extent to which the rays produce secondary radiation from different metals may be modified by passing the rays through screens, as Kleeman has shown. We do not, however, find any true selective absorption such as Kleeman suggests.

(6) If there are any secondary $\gamma$ rays, the ionisation which they produce is negligible compared with that produced by the secondary $\beta$ radiation, at least within a moderate distance of the radiator, say a metre in air.

All these facts can be explained very simply and directly on the neutral-pair theory; indeed, the theory guided us to the verification of most of them.

As regards (1), we have simply to suppose that the negative and positive passing united into an atom are separated if they happen to traverse a very strong field anywhere therein; the negative flies on, and the positive becomes ineffective.

The second property is also an obvious consequence of the hypothesis. The faster the $\gamma$ particle is moving, the greater the initial speed of the negative.

The third is readily explainable: the electric field of the atom is merely the solvent of the bonds that connect the pair. It is not able to affect the speed of the negative set free.

The fourth may be taken to imply that the radio-active atom (say Ra C) ejects electrons at a certain speed, some of which start off in company with a positive counterpart, some without. The former constitute the $\gamma$ rays, the latter the $\beta$.

The fifth would show that there are stronger fields inside heavy atoms than light ones, and that the chance of separation of the pair increases with (*a*) the strength of the field, (*b*) the time taken to cross it.

Turning now to the ether pulse hypothesis, it is convenient to consider it in two different forms, which are irreconcilable with each other.

In the first of these, both the electron and the electron's energy are supposed to be drawn from the atom, the $\gamma$ ray merely pulling the trigger. This theory requires us to accept the extraordinary idea that the primary ray, though it does no more than pull the trigger, determines the direction and velocity of the shot, and it offers no explanation at all of (1) and (4) (see above). We should naturally expect the velocity of the electron to be a function of the properties of the atom from which it is drawn, as in the well-known cases of true radio-activity. Moreover, all the radio-activity of which we have certain knowledge is not to be hurried or stayed by any external agency. It is true that Prof. W. Wien (Göttingen *Nachrichten*, 1907, p. 598) has made a tentative application of a theory of Planck's, and thence derived a formula $v^2\lambda = \text{const.}$, where $v$ is the velocity of the ejected electron, and $\lambda$ the thickness of the pulse. This provides a formula, but it satisfies (2) and (3) only; moreover, it seems to me that the difficulties remain as great as ever, and that the application of Planck's theory must be unjustifiable.

Passing on to the second form of the pulse theory, we now suppose the electron itself to be drawn from the atom, but its energy from the pulse.

I understand that this view is now held by Prof. J. J. Thomson (see Camb. Phil. Soc., vol. xiv., part iv., p. 417), and it is also maintained by Mr. N. R. Campbell ("Modern Electrical Theory"). New works often take some time to reach us here, and I have only just received a copy of this admirable book, but I hope I have understood it sufficiently well to enable me to describe the position correctly.

Since the energy of a pulse, if spread over an ever-widening surface, is utterly insufficient to provide the energy required for the secondary $\beta$ ray, Prof. Thomson and Mr. Campbell suggest that the pulse does not spread, but travels radially from the arrested electron along tubes of force, the latter being considered as things differentiated from the surrounding space. Prof. Thomson speaks of bundles of pulse energy travelling with the speed of light in straight lines. When a kathode particle strikes the anti-kathode, bundles dart away from the point of impact; when these impinge on atoms they drive out the electrons constituting the secondary rays. In this way the energy difficulty is explained, and possibly also the difference between the emergence and the incidence radiations. It must be remembered, however, that this difference may be very large. In the case of carbon under $\gamma$ rays, the one radiation is five or six times the other. Since the secondary $\beta$ ray has the same speed (nearly) as the primary kathode ray which caused the X-ray, it seems to me necessary to suppose that the arrest of the kathode particle must cause one bundle of energy of very small and invariable volume to travel out along one straight tube (and only one) connected to that particle. This causes the ejection of one electron from some atom into which it penetrates, giving all its energy to that electron. Similar arguments apply to $\beta$ and $\gamma$ rays. Surely it requires a very complicated structure of the æther to effect all this. I have too deep a respect for Prof. Thomson's work to say it is not possible to construct a theory on these lines, but I think I may fairly claim that the neutral-pair theory explains all the known properties of the $\gamma$ rays much more simply and completely.

Perhaps I ought to add that the theory, although it may require a detachable positive electron, does not require a free positive electron.

I have scarcely mentioned the X-rays. I am glad to see that Mr. Cooksey (NATURE, April 2, p. 509) has proved the difference between emergence and incidence radiation in their case also. It can now be said, therefore, that all the properties of the $\gamma$ rays as set out in the above summary hold for the X-rays also, *mutatis mutandis*.

University of Adelaide, May 5. W. H. BRAGG.

### Symbols for Physical Quantities.

IT is very desirable to have a notation for the representation of physical quantities in scientific books and periodicals, which shall be the same in all languages.

The subject is under the consideration of the International Electrotechnical Commission with a view to international agreement, and committees in the different countries (in England under the chairmanship of Lord Rayleigh, O.M.)

are discussing this particular subject. They are dealing more especially with symbols for electrical and magnetic quantities, but the system might with advantage be extended to embrace all important quantities in physical science, especially as the subject is receiving the attention of most technical societies with a view to some action being taken in the matter.

There are, however, two great difficulties which arise when we try to fix upon a standard notation.

The first is the difficulty of persuading a number of writers and readers who have become accustomed to a certain symbol for a certain quantity to change it in favour of an equally large number of writers and readers who have become accustomed to another symbol. For instance, in France and Germany the letter "I" commonly represents the strength of an electric current, while in England and America "C" is more commonly used.

In the second place, there are not enough letters in the two or three alphabets at our disposal to give a distinct symbol to each quantity, without resorting to the combination of more than one letter to form a single symbol. There is a great objection to this combination of letters, because the use of subscript letters and numbers is required for distinguishing between particular quantities of the same general kind. If, for instance, C represents current, $C_a$ might conveniently represent armature current, and $C_1$ the current in circuit No. 1. It would therefore not be good to take $C_a$ to represent capacity, or any quantity other than an electric current.

There is, moreover, an objection to using letters at all to represent quantities in a universal notation, because, unless initial letters are used, there is no connection in the mind between the letter and the quantity, and the symbol is difficult to remember. We cannot always use initials, because the initial letters differ in different languages. For instance, in England "R" commonly stands for resistance, while in Germany it is more convenient to use "W" for widerstand. Moreover, the same initial occurs for a great number of different quantites. For instance, "R" might stand for resistance, reluctance, reactance, radius, &c.

One way of avoiding the above difficulties would be to create a number of new symbols which could be printed by means of type like ordinary letters, and which would represent each physical quantity in a distinctive manner.

The question, however, arises as to whether a number of entirely new symbols would be acceptable to writers, readers, and printers alike, and the sub-committee on symbols appointed by the British section of the Commission has requested the writer to place his views publicly before the profession, with the view of obtaining suggestions and criticisms as to the feasibility of such a scheme from as wide a circle as possible.

In choosing a symbol, we would try to make a very simple picture of something that reminds us of the quantity in question. For instance, ⌡ might represent temperature. If we were told that this simple outline of a thermometer represents temperature, we would have no difficulty in remembering it. Similarly, / might represent force, and the various "forces" might be derived from it; for instance, ϟ electromotive force (conventional representation of lighting), and ∩ magnetomotive force.

It is not my purpose here to say what would actually be the best form of symbol for each quantity, but it is not a difficult matter to devise very simple characters which can be written quickly, easily, and with sufficient accuracy, and can at the same time assist the memory to connect them with the quantity for which they stand.

What would the printers say to the new type? The author has taken up this matter with a very large publishing firm, and is assured by their chief expert that 200 or 300 new types would be a small matter to a modern printer, who is already accustomed to deal with many hundreds of different founts, each of which contains from 50 to 120 different symbols. He estimates that a printer in a large way of business has at his command as many as 60,000 distinct types, differing from each other either in letter, size, body, or face. The addition of 200 or 300 more would be a drop in the ocean. The size of the new type could be standardised for most purposes, and it would only be in some special case that another size would be called for.

The setting up of the formulæ with the standard size of type would be simpler than with the present system, in which subscript letters are often unnecessarily introduced. One symbol under the present system sometimes consists of four or five letters.

If it be admitted that the introduction of new symbols is advisable, the question arises, what shall the new symbols represent exactly? Shall the sign ⌡ (temp.) represent temperature in any units, or shall it represent the number of degrees of temperature, measured by some scale agreed upon, and embodied in the definition of the symbol? If the system of units employed be not prescribed, fewer symbols would be required, and the general writer who now says vaguely, "Let T equal the temperature," would find the symbol sufficient for his purpose. But from the reader's point of view there is much to say in favour of a symbol which will embody in its definition a standard system of units. Any formula expressed in such symbols would be completely self-contained, and would be an exact statement of a physical fact. Until the units employed in any formula are known, the formula expresses only half its meaning. Perhaps some slight addition to the symbol, or even to the whole formula, might be used to indicate that the standard system of units is employed. Without that addition, the symbol would have a general meaning. For instance, ⌡ might equal temperature, while ⌡ might indicate the degrees centigrade above the absolute zero. The name of the type might be the name of the physical units which it represents; for instance, for ϟ we might read "volts."

If writers, printers, and readers who have any definite views as to the best method of devising a system of symbols would communicate with the author, they might assist in solving the many difficulties which arise in connection with this matter.

Miles Walker.

The Cottage, Leicester Road,
Hale, Altrincham.

### Linnæus's Authorities.

I am happily able to throw a little light upon the question raised by Prof. Karl Pearson in Nature of July 16 (p. 247). The citation he quotes is identical with that in the tenth edition of the "Systema Naturæ" (1756), p. 24.

"Bont. jav. 84. t. 84." will be found in Piso, "De Indiæ utriusque re naturali et medica," Amst. 1658. fol. The bastard title following the engraved title-page has towards the bottom this line:—"Iacobi Bontii, Bataviæ in majore Java novæ medici ordinarii, . . . " hence, no doubt, the form employed by Linnæus. This forms the third separately paged part of the volume, and on p. 84 is a woodcut of the "Ourang Outang sive Homo silvestris," &c.

"Kœp. itin. c. 86" is doubtless "Kiöping (Nils Matson) En reesa genom Asia, . . . . &c. Wisingsborgh, 1667. 4to."; I am quoting from Dryander's Catalogue of Banks's Library, vol. i., p. 86.

"Dalin. orat. p. 5." is referred to in Amœn. Acad., vol. vi., p. 74 as "Dalin in oratione Acad. R. Holm. de hac:" &c. I have not verified the actual speech, but it should not be difficult to run it down in the early volumes of the Handlingar.

B. Daydon Jackson.

Linnean Society, Burlington House, W.

### Elliptical Halos.

In Pernter's "Meteorological Optics" the explanation of haloes, based on a consideration of refraction and reflection in ice-crystals, is given at some length. In particular the elliptical halo described by Mr. Cave in Nature of July 16 (p. 247) is shown to be a form depending on the sun's altitude. If the sun is less than 25° above the horizon, the phenomenon appears as two arcs touching the 22° halo at its highest and lowest points. For altitudes greater than 70°, it is indistinguishable from the 22° circular halo.

It would be interesting to know if Mr. Cave observed the transition from the elliptical to the circular form.

E. Gold.

3 Devana Terrace, Cambridge, July 16.

## THE FIXATION OF ATMOSPHERIC NITROGEN AS CYANAMIDE.

In NATURE of August 30, 1906, an article was published describing the Birkeland Eyde process for the fixation of atmospheric nitrogen by electrothermic methods and the conversion of the nitric acid so obtained into calcium nitrate, which is used as a fertiliser in place of Chili saltpetre. Since that date the Birkeland-Eyde works at Notodden, in Norway, have been considerably enlarged, owing to the success which met their initial efforts. The necessity of obtaining large quantities of nitrogen in a form suitable for fertilising purposes does not require to be reiterated again, because the fact that the available sources are being depleted, and the demand for nitrogen for agricultural purposes continually increases, is now universally recognised. This has led many investigators to endeavour to fix atmospheric nitrogen in some other form, which it is hoped will be more economical than that of direct oxidation in the electric arc.

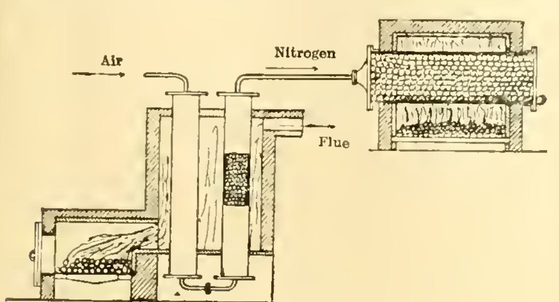


FIG. 1.—Nitrogen Absorption Retort.

The amount of Chili saltpetre exported in 1907 was 1,740,000 tons, and in order to replace this by the fixation of atmospheric nitrogen, it is necessary to employ 280,000 tons of the gas, and this is the amount which, it is calculated, is contained in the atmosphere over every nine acres of the globe. Another method of fixing nitrogen is known, and that is the formation of calcium cyanamide by the heating of calcium carbide in a stream of nitrogen obtained from the atmosphere. The researches which led to the discovery of calcium cyanamide were originally commenced by Drs. Frank and Caro in 1895, when they were endeavouring to produce cyanides by heating a mixture of calcium carbide and sodium carbonate in presence of nitrogen. The results were not very satisfactory, and therefore barium carbide was substituted, and this substance was found to absorb nitrogen with great avidity at between 700° and 800° C. It was intended to treat the barium cyanide with potassium or sodium carbonate, and thus produce the cyanides. On examination of the products produced, however, it was found that not only did barium carbide produce barium cyanide, but also a more complex compound was formed, which upon examination proved to be barium cyanamide according to the equation:—

$$BaC_2 + 2N = BaCN_2 + C.$$

The product obtained in the reaction usually contained 30 per cent. of barium cyanide and 40 per cent. of cyanamide, the remainder consisting of barium oxide and carbon. It was found, however, that the barium cyanamide and barium cyanide could easily be converted into potassium cyanide by melting with potassium carbonate as follows:—

$$Ba(CN)_2 + BaCN_2 + C + 2K_2CO_3 = 4KCN + 2BaCO_3.$$

Experiments were then taken up with calcium carbide, and investigation showed that by altering the conditions it was possible to convert the whole of the calcium carbide into cyanamide according to equation 1. Now when calcium cyanamide is decomposed by means of water, ammonia is produced thus:—

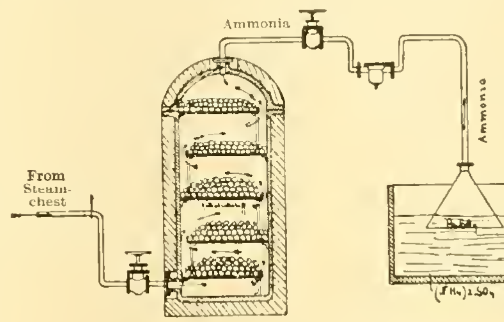


FIG. 3.—Ammonia Producing Apparatus.

$$CaCN_2 + 3H_2O = CaCO_3 + 2(NH_3).$$

It seemed, then, that it might be possible to obtain the ammonia for purposes of fertilisation, that is to say, employ cyanamide directly as a manure, but as the reaction only takes place with water at high temperatures, agricultural authorities were inclined at first to doubt the possibility of employing this product, as it was presumed the ammonia would probably not be liberated by the moisture of the soil. However, experiments showed that the cyanamide actually does decompose in the soil, and that it acts as a source from which plants can obtain the nitrogen which they require for nutriment. The product has therefore been put upon the market under the name of "Nitrolim." Some difficulties, however, were met with, one being that the finished product often contains some quantities of calcium oxide, therefore on exposure to moist atmosphere the nitrolim in-

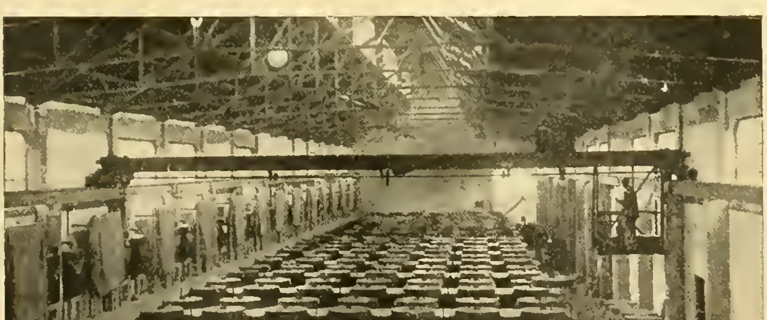


FIG. 2.—Electric Furnaces at Odda for producing Cyanamide.

creased in bulk, which was objectionable for storage purposes, as the jute sacks in which it was contained burst. By, however, taking precautions to line the sacks first of all with double paper, this difficulty was got over, and also by improved methods of manufacture the amount of lime produced was lessened.

As regards the actual part played by cyanamide in the soil various theories have been put forth; *e.g.* it would appear that when brought into contact with the ground the cyanamide is first decomposed through the action of the moisture and also of the carbon dioxide in the soil as follows:—

$$CaCN_2 + H_2O + CO_2 \rightarrow H_2CN_2 + CaCO_3,$$

and the free cyanamide will then, by absorption of water, probably be further decomposed into urea,

$$H_2CN_2 + H_2O \rightarrow CO\begin{matrix}\diagup NH_2 \\ \diagdown NH_2\end{matrix}.$$

Also the decomposition is greatly assisted by the myriads of microbes which are invariably found in cultivated soil.

Experiments have shown that calcium cyanamide is more suitable in some soils than in others, *e.g.* if the soil is in an acid state it is necessary previously to lime it. Such soils are found in high moorland and in sandy places because they are very poor in lime, and when applied to such land, cyanamide, unless lime is first added, is distinctly harmful, but with most other soils it is very satisfactory.

Nitrolim can also be mixed with other fertilisers, such as basic slag, potassium salts or superphosphate, but with this latter particular precautions have to be employed owing to the free phosphoric acid combining with the free lime in the cyanamide. This difficulty, it is stated, has now been got over. One advantage which cyanamide has over Chili saltpetre is that it is less soluble in water, and is therefore not so liable to be washed away in the drains and so lost, consequently the unchanged cyanamide which may have been left in the ground after the first harvest is readily available for the succeeding one.

FIG. 4.—Isere Valley, Nôtre Dame de Briançon.

Cyanamide is manufactured from calcium carbide of the same quality as that which is used for illuminating purposes. The carbide as it comes from the electric furnace is ground up and charged into retorts, which are made of fire-proof material, and are mounted in a furnace similar to the retorts employed for the manufacture of gas. (Fig. 1 shows this arrangement diagrammatically.) The nitrogen is then passed over the carbide, the retort being maintained at a temperature of from 800° to 1000° C. The nitrogen is produced either by the Linde system of fractional distillation of the air or by passing air over heated copper turnings, the resulting copper oxide being reconverted to the metal by passing reducing gases over it. In the Linde process the oxygen which remains after the separation of the nitrogen is a useful bye-product. As soon as the carbide in the retorts is saturated with nitrogen—a fact which becomes evident by the controlling gas meter coming to a standstill—the calcium cyanamide is extracted in the form of a hard cake, and is cooled in vessels from which air is excluded. When cool it is ground into a fine powder, and is ready for use.

During the last year a new electric furnace has been devised for heating the carbide while it is absorbing the nitrogen, and this has given such satisfaction that now all the older retorts are being replaced by the electrically heated ones. The process is cheaper, and the operating costs per furnace are lower, also the life of the retort is practically unlimited, which was not the case with the older retorts (Fig. 2 shows a number of these retorts in position.)

FIG. 5.—Main Buildings at Nôtre Dame de Briançon.

The yield of carbide at most works is about two tons per kilowatt year, and two tons of carbide will absorb practically 500 kilograms of nitrogen in the form of nitrolim. A power of about $2\frac{2}{3}$ h.p. is required per year for fixing each ton of nitrogen, and in addition to this about one-third horse-power is required for the grinding and all other mechanical operations. Consequently, to produce sufficient nitrolim to take the place of all the Chili saltpetre at present consumed annually, plant developing no less than 800,000 h.p. would be required. Not only is nitrolim useful as a fertiliser, but quite a large variety of chemical products have been made by means of it. For instance, by melting it with a flux, a mixture containing 25 per cent. of potassium cyanide, which is found to work quite as efficiently for the extraction of gold and silver as the pure product, is produced. It comes on the market under the name of "Surrogate." Ammonia may be produced very readily from this product, and may be collected pure or used for making salts of ammonia. (Fig. 3 shows diagrammatically the form of plant employed.) Another product is dicyandiamide, which is being used in increasing quantities for the manufacture of organic dyes. Besides which there are urea, thiourea, ferricyanide, and a variety of other products.

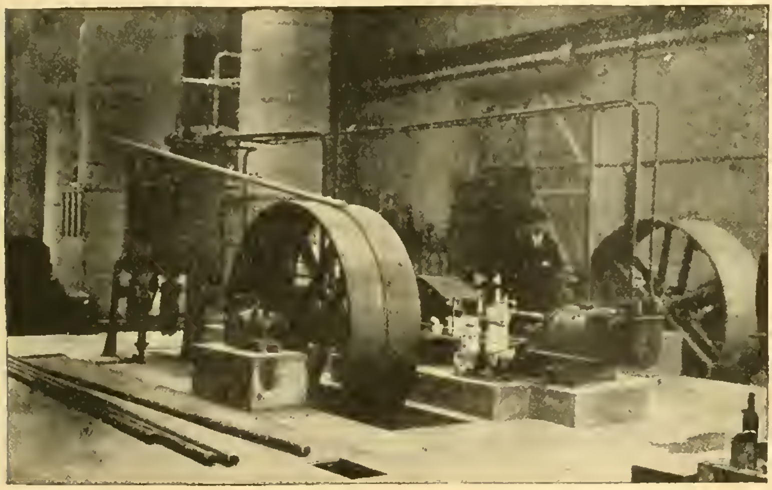


FIG. 6.—Linde Machinery.

As a commentary upon the Birkeland-Eyde process worked at Notodden, it is of interest to notice that the Cyanamide Company at Odda fix about the same quantity of nitrogen as the Birkeland-Eyde; but whereas the former employed about 25,000 kilowatts of power, the energy required by the latter company is between five and six thousand kilowatts. It would thus appear that the actual fixation is cheaper in the form of cyanamide than in that of calcium nitrate. At the end of the present year it is hoped that works having a total output of 45,000 tons of nitrogen will be in operation, and in the course of next year a correspondingly large increase in production of this product is predicted. It should be mentioned that the first plant upon an industrial scale was started about two and a half years ago, at Piano d'Orta, in Central Italy, with a yearly production of about 4000 tons of nitrolim. These works are now being increased to a capacity of 10,000 tons. Other important works are being started in Italy; the power employed is hydro-electric.

Works are being erected in Austria-Hungary, and at the present time a water-power installation, giving at least 50,000 h.p., is being erected at Almissa. In France the Société Française des Produits Azotés has installed works at Nôtre Dame de Briançon (Haute Savoie) having an output of 4000 tons, and these have been in operation for about six months. In Germany, at Westeregeln and Brühl, on the Rhine, 10,000 tons of nitrolim are being annually manufactured. It should be noticed, however, that the works at Brühl do not employ water power, but as the coal in this district is cheap, it is used in place of water power. In the United States the American Cyanamide Company are constructing works on the Canadian side of the Niagara Falls, with a capacity of from five to six thousand tons per annum, which it is hoped to enlarge later on so as to produce 40,000 tons.

The chief British enterprise is the North-Western Cyanamide Company, Ltd., which has erected works at Odda. Figs. 4 and 5 show the Isere Valley, Nôtre Dame de Briançon, and the main buildings of the cyanamide works. Fig. 6 shows the Linde machinery employed there for fractional distillation of the air.

F. M. P.

## THE EDUCATION OF THE BLIND.[1]

THE jubilee year of the Institution for the Blind at Illzach-Mülhausen has been celebrated by the publication of a "Festschrift," which contains addresses and papers by Prof. Kunz and others at the congresses regarding the blind held in Frankfort in 1882, Amsterdam, 1885, Kiel, 1891, Berlin, 1898, Paris, 1900, Breslau, 1901, Halle, 1904, Leipzig, 1905, and in Rome, 1906. There is first an interesting account of the development of the Institution at Illzach since its foundation in 1856. Institutions for the blind were founded in various cities long before this date. Thus, to select from a long list of the chief cities of the world, we find one in Paris in 1784, in Liverpool (the first English institution), 1791, Edinburgh, 1793, London, 1799, Berlin, 1806, St. Petersburg, 1807, Stockholm, 1808, Dublin, 1810, Barcelona, 1820, Munich, 1826, New York, 1831, Bern, 1836, Padua, 1838, and Madrid, 1842.

The home at Illzach was at first small and modest, but it grew rapidly, and now it is one of the best equipped blind asylums. From the first its founders had in view that it was not merely to be a home for the blind, but a school in which all the elements of an ordinary education, and also of a technical education, could be taught. Nothing is more ingenious than the methods now adopted for the education of the blind, more especially by the sense of touch. Reading by raised type, or by a system of raised points so grouped as to represent numerals or letters, arithmetic, grammar, geometry, geography by raised maps, natural history by specimens of plants and animals or by anatomical models, or the outlines of plant and animal forms in bas-relief, music—theoretical, vocal, and instrumental—and gymnastics, and many technical arts are also taught, such as sewing,

[1] Geschichte der Blindenanstalt zu Illzach-Mülhausen i E. Während der ersten fünfzig Jahre ihrer Tätigkeit, ferner deutsche, französische, und italienische Kongressvorträge und Abhandlungen über das Blindenwesen, Prof. M. Kunz, Direktor der Anstalt, 1856–1906. Pp. 346 . Leipzig: Wilhelm Engelmann, 1907.)

knitting, basket-making, mat-making and brush-making. Special maps and even pictures are now made for the blind. There are numerous illustrations of these in the volume. The blind children are taught to take part in plays, some of which are complicated enough to tax the powers of those having vision, and, of course, in music of all kinds, many of the blind attain to remarkable proficiency.

The second part of the work deals with the various congresses. These were largely attended, and papers were read which opened discussions on the best methods of teaching the blind. Each congress had its own speciality. Thus at Kiel, 1891, the subject was the modelling of animal forms; and at Berlin, 1898, it was the teaching of music and grammar. Even comparative grammar was taught to advanced pupils, and those interested in the relationships of languages will find much that is suggestive in the record of the Berlin conference (pp. 130–145). At the Paris conference in 1900, the important question was discussed whether blind children should be taught by blind teachers, and, if so, to what extent? There appear to have been considerable differences of opinion upon this point. The French, Belgians, and Italians made great use of blind teachers, but in Germany and other northern countries the greater part of the teaching was done by those who see, and the blind teachers were only helpers. Prof. Kunz has an important article on this question, and he has arrived substantially at the conclusion that the proportion of seeing to blind teachers should be about two to one. Many blind teachers have, however, attained wonderful skill in imparting knowledge to their unfortunate brethren, and a feeling of sympathy and subtle intuitions, related to personal experience, may to some extent account for their success.

One of the most interesting chapters in the volume is that entitled Zur Blindenphysiologie, das sogenannte "Sinnenvikariat" (p. 186). It might be called the "psycho-physik" of the blind. The results of various experimental inquiries are given, and it is shown that in the blind, taking the average of a large number above puberty, all the other senses are capable of more delicate perceptions than in those who can see. As might be expected, the sense of touch is highly developed. This is of great importance, as it enables the blind to use with accuracy the Braille method of designating letters by various patterns of points, which are sometimes sharp and of varying size, sometimes wedge-shaped, and sometimes the marks consist of thin vertical and horizontal lines, either single or meeting at various angles. An address by Prof. Kuntz at Halle, in 1904, gives much information as to the spread over the world of the methods of teaching the blind. This is followed by an interesting description, with numerous illustrations, of the many forms of type suitable for reading, for arithmetic, and for music, and nothing could show more clearly the delicacy of the sense of touch acquired by the blind during their education than an inspection of these curious patterns. Dr. Javal, the eminent Parisian ophthalmologist, contributes an interesting chapter on some physiological features of the blind.

There is an elaborate paper bearing on the perception of the direction of sound by the blind, and the acuteness with which they perceive the nearness and often the nature of objects by reflection of sound-waves. The whole subject has been investigated with the greatest care. It is interesting to find a translation into modern Greek by Fräulein Irene Lascaridi (a teacher in the Asylum for the Blind in Athens) of Prof. Kunz's paper on the physiology of the blind, *Περὶ τῆς Φυσιολογίας τῶν Τυφλῶν*. Several examples of raised type and maps are shown at the end of the volume. The book is not only worthy as a "Festschrift," as it contains all that can at present be written upon the subject of the education of the blind, but it will be an enduring monument to the zeal, devotion, and learning of Prof. M. Kunz, who has devoted his life to the interests of those who are deprived of one of the most important of the senses.

JOHN G. MCKENDRICK.

## CATALOGUE OF DOUBLE STARS.[1]

PROF. G. W. HOUGH, director of the Dearborn Observatory, while observing with the $18\frac{1}{2}$-inch refractor, discovered 648 double stars. These stars consist of close pairs and of pairs where the companion is very faint; they are, therefore, difficult to measure, and may be regarded as of the same class as those discovered by Prof. Burnham. But whereas the Burnham stars have been fairly well observed and yield a good percentage of binaries, the Hough stars have been very little observed, and they yield few interesting pairs.

Prof. Doolittle, of the Flower Observatory, has done good work in collecting these 648 stars in one catalogue, and arranging this catalogue in a form which leaves nothing to be desired. The stars are not entered according to the Hough number, but in order of right ascension, and the meridian catalogue name is added; but to facilitate reference, a list of the stars is given in order of the Hough number, with the page in the catalogue on which the star appears.

In addition to his own measures, made at the Flower Observatory of the University of Pennsylvania, Prof. Doolittle gives measures by other observers, which unfortunately are few. From the Astronomer Royal's report and from the Greenwich results published in the Monthly Notices of the R.A.S., we gather that the Greenwich observers have been at work on the Hough stars, and it seems a pity that more of these measures could not be included. It may be that Prof. Doolittle experienced difficulties in publication which retarded the appearance of his catalogue. This would make it seem of later date than it really is, and would also explain the phrase in the introduction—"Mr. Burnham's new general catalogue, when it is published," &c. The general catalogue has been with us since August last.

The right ascensions and declinations are given for 1880. This, in a catalogue of 1908, means that the right ascensions are practically $1\frac{1}{2}$ m. wrong to start with, and the declinations sometimes 8′ or 9′ out, thus necessitating the application of precession corrections by everyone using the work, whereas if the places had been given for 1910 they would have been useful for many years.

Prof. Doolittle began systematic work in 1901, and the catalogue he has produced is an important piece of work well carried out, and the printing is very good, the few errors being easily rectified. But owing somewhat to the uninteresting character of the Hough stars, he has had little beyond the actual catalogue itself to repay him for his labour. With the exception of Hough 212, and possibly two others, there is no object in the whole catalogue of any remarkable interest at present; and the paragraph on p. 10 of Prof. Doolittle's introduction must evidently be read in the light of the well-known characteristics of the Hough stars. In this paragraph he gives thirty pairs as being *clearly binary systems in rather rapid motion.*

Astonishment at the large number was increased on an analysis of the thirty. From the notes in the

[1] "Catalogue and Re-measurement of the 648 Double Stars discovered by Prof. G. W. Hough." Publications of the University of Pennsylvania, Astronomical Series, vol. iii., part iii. Pp. 176. (Pennsylvania, 1907.)

body of the work, *i.e.* in Prof. Doolittle's own words, we find these consist of two pairs in which there is no evidence of motion; five pairs in which change is doubtful; five pairs in which some change is probable; seven pairs where the change is less than 1°·0 per annum; six pairs where the change is just over 1°·0 per annum; two pairs where it is approximately 2°·0 per annum; two pairs fairly rapid binaries; one pair, Hough 212, with a period of 5·7 years.

The last five only can be brought under the above phrase.

There are two rather serious errors in identification: Hough 198 should be B.D.+16°.4896, not WB (2)xxiii.195, the declination of which is 42°, not 16°; Hough 507 should be WB(2)iv.151, declination 37°, not WB(2)iv.154, declination 32°.

## NOTES.

We regret to see the announcement of the death on July 20 of Mr. Arthur Lister, F.R.S., distinguished particularly for his researches on the Mycetozoa. Mr. Lister was seventy-eight years of age, and was elected a Fellow of the Royal Society in 1898.

Sir John Banks, first president of the Royal Academy of Medicine, Ireland, and a leading authority on mental diseases, died on July 16 at ninety-seven years of age.

The eighth meeting of the Association of Economic Biologists will be held at Edinburgh on Tuesday, Wednesday, and Thursday, July 28, 29, and 30, under the presidency of Mr. A. E. Shipley, F.R.S., who will deliver a presidential address "On Rats and their Parasites" on July 28.

We learn from the Journal of the Meteorological Society of Japan that the death of H.I.H. Prince Yamashina occurred on May 2 at thirty-one years of age. The late Prince had deep interest in meteorology and allied sciences. On his own account he established the Mount Tsukuba meteorological observatory and two base stations in 1901, and published a series of "Ergebnisse der meteorologischen Beobachtungen auf dem Tsukubasan." He made several valuable researches in meteorology and seismology, and designed a number of excellent instruments.

Dr. Ludwig Mond, F.R.S., has offered to the Reale Accademia dei Lincei a biennial international prize of 400*l.*, to be called the Stanislao Cannizzaro prize, for chemistry and physical chemistry. The amount necessary for providing the prize, together with taxes and expenses, is to be given by the donor in the form of Italian Consols, while the conditions of award have been placed in the hands of the president of the Academy, in consultation with Dr. Mond and Senator Cannizzaro.

The Paris correspondent of the *Times* states that a Society of the Observatories of Mont Blanc has just been regularly constituted, with a board of directors largely chosen from the Academy of Sciences, for the more systematic continuation of the work begun by the late M. Janssen and M. Vallot. The society has decided to place the Vallot and Janssen observatories under the direction of M. Vallot. With this object the latter has given his establishment to the society just formed—a purely scientific association—which appeals for members and funds. The secretary is Comte de La Baume-Pluvinel, 9 Rue de La Baume, Paris.

We are informed that the optical illusion observed by Dr. T. Terada, Tokyo, and described on p. 255 of our last number, has been previously observed and described. In the Proc. Roy. Soc., Edin., 1878–79, there is an account of some experiments on this illusion. Like Dr. Terada, the writer first observed it after looking at moving water, but in his case it was a quickly flowing stream; on afterwards looking at the gravel bank a stream of gravel seemed to flow slowly through it in a direction the opposite of that of the water. A number of experiments are described in the paper referred to on the effect of looking at rotating discs with black and white radii, and moving bands of paper with cross-lines, the eyes being afterwards directed to a mottled surface on which the reverse movements referred to appeared. These spectra were shown to be entirely stopped when a straight line was drawn across the surface.

An international exhibition and congress of the applications of electricity will be held on September 14–20 at Marseilles. The object of the congress is the consideration of the technical, commercial, and administrative problems which have arisen in recent years. These questions will be treated in reports prepared by well-known authorities, and the reports will be submitted to the congress for discussion, and published subsequently. The business of the meeting will be transacted in nine sections dealing with, respectively, the framing of regulations; the construction and protection of electric wiring; technical and commercial workings; lighting and domestic applications; applications to industry, mines, traction, and agriculture; electro-chemistry and electro-metallurgy; telegraphy and telephony; instruction and measurements; and applications to hygiene and medicine. Numerous papers, none of which, we understand, is the work of a British authority, will be discussed in each section. Prof. Maurice Lévy will be the president of the congress. There are four general secretaries, MM. Armagnat, Chaumat, and Dusaugey, and Prof. Zimmern, who may be addressed at 63 Boulevard Haussmann, Paris.

Commander Peary departed on July 17 from Sydney, Nova Scotia, on the *Roosevelt*, on his voyage to the North Pole. A *Times* correspondent reports that Commander Peary has summarised the main features of his programme thus: First, the utilisation of the Smith Sound route, the advantages of which are a land base 100 miles nearer the Pole than is to be found at any other point of the entire periphery of the Arctic Ocean, a long stretch of coast-line upon which to return, and a safe and (to Commander Peary) well-known line of retreat in the event of any mishap to the ship, independently of assistance. Secondly, the selection of a winter base which commands a wider range of the central polar sea and its surrounding coasts than any other base in the Arctic regions. Cape Sheridan is practically equidistant from Crocker Land, from the remaining unknown portion of the north-east coast of Greenland, and from Peary's "Nearest the Pole" of 1906. Thirdly, the use of sledges and Esquimaux dogs. "Man and the Esquimaux dog," Commander Peary observes, "are the only two machines capable of such adjustment as to meet the wide demands and contingencies of Arctic travel. Airships, motor-cars, trained Polar bears, &c., are all premature, except as a means of attracting public attention." Fourthly, the use of the Whale Sound Esquimaux for the rank and file of the sledge party.

The president of the Local Government Board has authorised for the current year the following researches in connection with the annual grant voted by Parliament in aid of scientific investigations concerning the causes and processes of disease:—(1) A further inquiry by Dr. M. H. Gordon into the character and differential tests for the micro-organisms found in the throats of patients suffering from scarlet fever. (2) An investigation of protracted and recurrent infection in diphtheria. This will be undertaken by Dr. Theodore Thomson and Dr. C. J. Thomas. The bacteriological part of the investigation will be undertaken by the Lister Institute. (3) An investigation of protracted and recurrent infection in enteric fever. This will be undertaken by Dr. Theodore Thomson, in conjunction with Dr. Hedingham, of the Lister Institute. (4) Investigations by Dr. W. G. Savage into the presence of paratyphoid bacilli in man, the differentiation of streptococci in goats, and the bacteriological measurement of pollution of milk. (5) A statement of the results of the bacteriological examination of more than 7,000 samples of milk from different parts of the country, made by Prof. Delépine. (6) An investigation into flies as carriers of disease, by Dr. Copeman,, F.R.S., with the co-operation of Prof. Nuttall, F.R.S. (7) An inquiry into the condition of flock beddings, by Dr. Farrer. The bacteriology and biology of bedding (especially in relation to vermin), which will be undertaken in connection with this inquiry, will be superintended by Prof. Nuttall. (8) A statistical inquiry into the social incidence of disease will also be begun, the prevalence of varicose veins and of hernia under different social conditions forming the first subject of inquiry under this head. This will be undertaken by Dr. Basil Cook. Announcements of further investigations for the current year will be made at a later date.

THE Fourth International Fishery Congress will be held under the presidency of Dr. Hermon C. Bumpus at Washington, D.C., U.S.A., on September 22–26, to deliberate on important matters relating to fishing and fish culture, and to submit propositions for the benefit of the fisheries to Governments and to State, provincial, and local authorities. The congress will be organised and conducted in conformity with the decisions for the regulation of the international fishery congresses decreed in Paris in 1900. The membership will consist of Government, State, and provincial representatives, delegates from home and foreign societies, corporations, invited persons, and persons who express a wish to take part in it. In response to invitations from the United States Government, twelve national Governments have signified already their intention to be represented officially, and delegates have been appointed by the governors of many of the States of the United States. Very few nations have indicated formally their inability to participate officially, and the congress promises to be really representative in character. Among the important subjects to be discussed may be mentioned: commercial fisheries; matters affecting fishermen and the fishing population; legislation and regulations relative to fishing, fish culture, pollution of waters, and obstruction of waters; international matters affecting fisheries; aquiculture; acclimatisation; fishways and fish ladders; biological investigation of the waters and their inhabitants; diseases and parasites of fishes, crustaceans, molluscs, and other water animals; and angling and sport fishing. Suitable arrangements will be made for the entertainment and instruction of the members in Washington and at the other places visited, and an opportunity will be given for visits to places of general interest. All communications and inquiries before September 20 should be addressed to Dr. Hugh M. Smith, the secretary-general of the congress, Bureau of Fisheries, Washington, D.C.

THE morphology and physiology of the gephyreans of the family Priapulidæ are discussed by Mr. L. A. Moltschanov in a paper published in the June issue of the Bulletin of the Imperial Academy of St. Petersburg. The author regards the genus Priapuloides as intermediate between Priapulus and Halicryptus.

RICHARD CAREW (1555–1620) forms the subject of the second instalment of "Early British Ornithologists," by Mr. W. H. Mullens, now being published in *British Birds*. In connection with this we may perhaps be permitted to direct attention to the inconvenience of that title as the designation of a serial. In quoting we refer, for instance, to Mullens, *British Birds*, vol. ii., p. 42, while we should in like manner refer to Yarrell, *British Birds*, vol. i., p. 10. Who is to know in such cases whether it is to the serial or to a separate work that the quotation refers?

A SECOND report on the copepod crustaceans of the Irish Atlantic slope, by Mr. G. P. Farran, has just been issued in "Scientific Investigations, Irish Fisheries," for 1906, No. ii. The list given is mainly the result of a number of deep-water tow-nettings taken in 1904–5, and may be regarded in the main as a contribution to our knowledge of the plankton of the zone between 600 and 1000 fathoms. No. viii. of the same issue is devoted to reports concerning the obstacles to the ascent of young eels up the Irish rivers and the illegal capture of the fry.

THE Royal Scottish Museum has issued a general guide-book to the collections, at the price of one penny. Considering that it comprises only 63 pages and includes the artistic, ethnographical, natural history, and technical collections, the notices of each group are necessarily of the briefest. Although the type of the main text is small—too small, we think, for a number of persons who ought to avail themselves of the guide—the "catch-words" are printed in heavy block type well calculated to attract the attention of the reader.

WE are indebted to Mr. L. M. Lambe for a copy of a paper from the first volume of the third series of the Transactions of the Royal Society of Canada on the remains of a new type of crocodile from the Cretaceous formation of the Judith river. This crocodile, for which the barbarous name *Leidyosuchus canadensis* is suggested, is a broad-nosed form recalling Diplocynodon, but with the splenial included in the short mandibular symphysis, as in some of the Goniopholididæ. Possibly it may be a direct descendant of the latter—an idea supported by the fact that several members of the Judith river fauna present a Jurassic *facies*.

THE ninetieth volume of the *Zeitschrift für wissenschaftliche Zoologie* is published in a single issue of 677 pages, with 43 plates, of which several are coloured. All the eighteen papers are devoted to invertebrates. Among these, special reference may be made to one by Mr. F. Blochmann on the taxonomy and geographical distribution of brachiopods. The paper is illustrated with a large map, in colour, showing the distribution of Liothyrina, a genus most numerously represented in the neighbourhood of the Gulf of Mexico on the one side of the Atlantic, and the Spanish and north-west African coast, together with the Mediterranean, on the other. This distribution seems to confirm the theory of the existence until comparatively recently of a belt of shallow water across the mid-Atlantic. Further, the distribution of this and other genera indicates, in the author's opinion, the existence during Tertiary times of a communication between the Atlantic and the Indian Ocean by way of the isthmus of Suez.

THE results of a number of experiments with regard to the inheritance of colour and the head-crest in canaries undertaken at the Carnegie Institution of Washington are recorded by Mr. C. B. Davenport in publication No. 95 of that body, the report being illustrated with three coloured plates. After referring in some detail to the introduction and cult of the canary as a cage-bird, the author observes that in some respects this species, owing to the comparatively short time it has been under the influence of domestication, is better adapted for investigations of this nature than animals which have been longer subject to human influence. As regards colour, it appears that the domesticated yellow breeds are derived from the original "green" breed by the loss of the black, and that it consequently carries a mottling factor which leads to the production of mottled hybrids when crossing takes place with a pigmented canary or a finch. Although such hybrids do not display a fixed pattern, the degree of their mottling is heritable. Further, the principle of localisation of the unit of complex plumage-colour must be recognised, as is exemplified by the restriction of a red patch to the sides of the face in hybrid canary-goldfinches.

ON the occasion of succeeding to the presidency of the Royal Microscopical Society for the second time, Lord Avebury delivered an address on seeds, with special reference to British plants. The president confined himself to a synopsis of the forms occurring in the British dicotyledonous orders and indicated the biological significance of the various devices met with. The paper is printed in the June number of the society's journal.

FROM Messrs. Gallenkamp and Co., London, a new catalogue of museum jars and window aquarium apparatus has been received. It also contains an illustrated list of Smedley's models. The models of Palæozoic seeds and cones, which are on view in the Hall of Science at the Franco-British Exhibition, have met with the universal approbation of botanists; the models of cryptogamic plants, flowers and seeds, and of invertebrates are less generally known. They are all modelled in hard wax on a rigid foundation.

THE editorial article in the June number of *Tropical Life* deals with the arrangements made for insurance against gales, hurricanes, and earthquakes as applicable to Jamaica and other West Indian islands. These permit of the insurance of such crops as limes, cocoa, and cocoanut-trees. Cotton can be specially insured against damage during the hurricane months July to October. In the same journal Mr. F. T. Crawley discusses the value of manures for lands planted with sugar-canes. With reference to the experience of planters in the Hawaiian islands, it is stated that fertilisers containing ammonia, phosphoric acid and potash are found to lead to an increased proportion of sucrose.

HAVING for twenty years pursued the study of the resinous substances found in plants, Dr. A. Tschirch laid before the Chemical Society of Switzerland, in response to its invitation, a paper treating of the chemistry and biology of plant secretions, with special reference to the resins. The author classifies the resinous substances according to the various products that are associated with the pure resin, and distinguishes *tannol resine, resinol resine,* and *harzsaure*, also such extraneous substances as ethereal oils, gums, &c. With reference to their systematic value, it is observed that while the orders Dipterocarpaceæ, Burseraceæ and others are characterised by definite groups of resins, other resins occur in plants quite unrelated. But it is suggested that for distinguishing between certain resin-producing species, chemical tests based on the secretions might be devised. The lecture has been published in pamphlet form.

THE results of an expedition in the Atlas Mountains of Morocco, made by M. Louis Gentil in 1906–7, are given in *La Géographie* for March. From the data obtained, a valuable map has been drawn up, indicating the main geological features of the High Atlas Mountains from the west coast to the region of Demnat. In an article accompanying the map, M. Gentil discusses the various difficulties encountered in obtaining accurate observations, and emphasises the utility of geological methods in mountain exploration. Information has been obtained of the hitherto little-known regions of Ounila, Anr'mer, Sous, and Siroua, the characteristic geological structure of the last being especially noticed. In an orographical sketch of Morocco, the regions of the High Atlas, Middle Atlas, and Anti-Atlas are distinguished, and the main features shown on a map.

MR. W. H. WHEELER has prepared a paper on the physical characteristics, tides, currents, and fisheries of the North Sea (J. D. Potter, 145 Minories). In the first section an account is given of the pre-Glacial condition of the North Sea, the main features being a deep fiord in the north branching out of the Atlantic, a large estuary south of the Wash, and an isthmus joining England to the Continent. In the post-Glacial period the mouth of the fiord between Durham and Yorkshire became blocked up, sandbanks were formed, and the channel which now forms the Strait of Dover was scooped out. This section of the paper includes also a description of the Dogger Bank, and illustrations of the depression of the land on the east coast of England and in the Low Countries. The making of new land by the deposit of glacial drift covered by alluvium is discussed, examples being drawn from the coasts of Belgium and Holland. The opposite effect of erosion is observed along the English coasts. An account is given of the Orkney and Shetland Islands, and the east coasts of Scotland and England are described in detail. The progress of the tidal wave in the North Sea is traced, velocities and range of the tides being given, with a table showing the effect of winds on the tides. As the result of experiments made by the Fishery Board of Scotland, the general drift of the surface currents in the North Sea was shown to be southerly down the coasts of England and Scotland, then south-east round the Dogger Bank, and, finally, east-north-east to the Skager-rack. Statistics of the fishing industry are given in the section dealing with this subject.

THE first application of the Kimberley method of diamond washing to the concentration of alluvial tin is described by Mr. H. D. Griffiths in the *Mining Journal* of July 11. The new method has been adopted at Kuils River tin mines, Cape Colony, and has given such exceptional results as regards efficiency and economy that the sluicing methods formerly in use on the property have now been discarded.

THE British Fire Prevention Committee has issued a red book (No. 127) on fire tests with fire extinguishers. The series of tests with the "Diamond" dry powder extinguisher showed that hand powder fire extinguishers, as a class, if applied with skill, can often be usefully employed in the incipient stages of small fires. The various tests undertaken with petrol point to the conclusion that, with a volatile liquid of this nature giving off a highly inflammable vapour, the powder extinguisher is only efficient when the area of the fire is small or narrow. The efficiency of powder extinguishers depends materially on the closeness of range, the position of the operator's shoulder, and on a certain knack or dexterity in handling the appliance. The action of powder extinguishers would appear to be largely mechanical.

We have received from the Deutschen Gesellschaft zur Bekämpfung des Strassenstaubes a pamphlet of thirty-five pages, in which Colonel Layriz has compiled from the scattered notes in technical journals a report on the methods at present in use to obviate the dust nuisance on roads. The data collected tend to show that efficacious methods are now available for obviating the formation of dust in densely populated cities and in the vicinity of summer resorts, but that the unavoidable cost renders it impossible to apply such methods, except by degrees, so as to make country high-roads free from dust.

The June number of the Journal of the Franklin Institute is of special interest to metallurgists. Mr. E. A. Custer has a copiously illustrated article describing the casting of pipes in permanent moulds that the hottest iron attainable from the cupola does not destroy. The method is one deserving careful attention, for it has long been the dream of every foundryman whose trade requires a large number of duplicate castings to make such castings in moulds that would not merely survive the process, but would also produce castings that would be marketable and be easily machined. Mr. G. B. Heckel reviews the methods in use for protecting iron and steel against corrosion, and Mr. H. P. Cochrane discusses engineering practice as applied to the handling of fuel at power stations.

Numerous attempts have been made to obtain ammonia from peat, but the difficulties of dealing with a substance which often contains 90 per cent. of water have hitherto proved insuperable, and none of the methods has survived the experimental stage. We have received an account of the Woltereck process, stated by the inventor to have overcome successfully all these difficulties. The peat is slowly decomposed at a regulated temperature by means of a blast of air charged with water vapour, and forms "paraffin tars," acetic acid, and ammonia. These pass successively through a scrubber to remove tar, an alkali tower containing a hot solution of caustic soda or milk of lime to absorb the acetic acid, and finally through an acid tower, where the ammonia is taken up by sulphuric acid. The tar on distillation yields a wax said to be worth 4*l.* a ton; the acetate is to be utilised for preparing either acetic acid or acetone. The ash of the peat is a saleable manure, and contains potash, lime, and phosphoric acid. It is estimated that the cost of producing the sulphate of ammonia will not be more than 5*l.* 8*s.* per ton, and, as the present market price is 12*l.*, a considerable profit is anticipated.

The officiating director-general of observatories (Mr. J. H. Field) has issued a memorandum, dated June 9, on the meteorological conditions prevailing in the Indian monsoon region before the advance of the south-west monsoon of 1908, with an estimate of the probable distribution of the monsoon rainfall. Account is taken, as usual, of the recent conditions over a wide area, including parts of Australia, Africa, Siberia, and South America, and all the available data have been analysed by the method developed by Dr. Walker and described by him in his forecast for last year. The result indicates, *inter alia*, that the total rainfall for the whole of India during the period from June to September will probably be nearly normal or in slight defect.

We have received part ii., vol. xx., of the Memoirs of the Indian Meteorological Department, containing kite observations made by Mr. J. H. Field at Belgaum (Bombay Presidency) during the pre-monsoon and monsoon periods in 1906, in continuation of those begun at Karachi in 1905 (published in part i.). One series was made in May, in which month the normal weather is dry and hot; the records, which are diagrammatically shown, indicated no marked increase in wind velocity up to 1300 metres, the maximum height reached. Temperature gradients were strong, by day always considerably above the adiabatic rate for unsaturated air. Comparatively humid air extended on different days to a height of 600–1100 metres; above it exceedingly dry air was met with. The other series was made in August and September, when the weather was comparatively cool, with frequent rain, especially in September. The wind velocity was, on the whole, nearly uniform up to the maximum height reached, 2500 metres. The temperature gradients were considerably smaller than in May and, except near the surface, always below the adiabatic rate. The upper limit of humid air had risen by about 1000 metres since May.

With reference to the article on recent developments in electric lamps which appeared in our issue of June 25, we are informed by the General Electric Co. that the statement to the effect that tungsten lamps for high voltages, 200 and above, have not yet been commercially introduced is not correct, as they have had these lamps on the market since the commencement of April. This firm is now in a position to deliver Osram and Wolfram lamps up to 260 volts pressure in 50 and 100 candle-power sizes and lamps for 100 to 130 volts in 25, 30, 50, and 100 candle-power sizes. In addition to this, 25-volt lamps are made for 10, 16, and 25 candle-power, and there is a large demand for this type of lamp for private plants and for alternating-current circuits where advantage can be taken of the possibility of transforming down the voltage. The company sends us two very well arranged catalogues setting out the advantages and possibilities of these lamps.

Vol. v. of Contributions from the Jefferson Physical Laboratory of Harvard University consists of reprints of ten papers by the staff and students which appeared in the Proceedings of the American Academy, the *Physical Review*, &c., during the year 1907. Of those not already noticed in these pages may be mentioned a paper by Mr. G. W. Pierce on "Crystal Rectifiers for Electric Currents and Electric Oscillations," part i., in which the author follows up and explains the fact recently discovered by General Dunwoody that a crystalline mass of carborundum between two electrodes will act as a receiver for electric waves when used either with or without a cell in series with it. This property is shown to be due to carborundum not following Ohm's law, but conducting better for high than for low voltages. It thus falls into line with other detectors of electric waves investigated by Profs. Braun and Strientz. The author is not yet prepared to advance any theory as to the cause of the phenomenon, but considers that there is sufficient evidence to show that it is not of thermoelectric origin.

Mercury has usually been regarded as completely insoluble in water and other solvents. It has, however, a definite vapour pressure, although a very low one at ordinary temperatures, and since no gas is completely insoluble in water, it appeared not improbable that this vapour should prove to be slightly soluble in water. This question is dealt with by Mr. A. Christoff in the current number of the *Zeitschrift für physikalische Chemie* (June

30), the experiments described being conceived with much ingenuity. The reducing action of mercury upon a solution of gold chloride was relied upon for detecting the extremely minute amounts of mercury involved, great care being taken to eliminate disturbing influences. The solvent action of water, benzene, nitrobenzene, and alcohol on mercury is clearly proved, and it was also shown that the effects observed could not be attributed to the formation of an oxide or hydroxide of mercury.

THE *Bio-Chemical Journal* for June (iii., No. 5) is mainly occupied with papers by Prof. P. W. Latham on the synthesis of protein. Taking the results of Schutzenberger, obtained by the hydrolytic decomposition of egg-albumin with baryta, the author analyses them and attempts to reconstruct a formula for albumin.

A THIRD edition of "Determination of Radicles in Carbon Compounds," by Profs. H. Meyer and J. Bishop Tingle, has been published by Messrs. John Wiley and Sons, of New York. Messrs. Chapman and Hall, Ltd., publish the book in this country at the price of 5*s*. 6*d*. net. The new matter, running to fifty-five pages, has been placed at the end of the volume in the form of an appendix, and copious cross-references have been provided.

WE have received a copy of a new periodical devoted to scientific subjects, and entitled the *Scientific Monthly*, an illustrated journal of science. There are contributions dealing with electrical, astronomical, chemical, and microscopical subjects, and numerous notes on scientific questions of current interest. The articles are of a general informative character and are illustrated. The magazine, the price of which is 3*d*., is published by Mr. Arthur N. Kemp, 26 Shaftesbury Avenue, London.

WE have received from Mr. Bernard Quaritch, of Grafton Street, New Bond Street, London, W., copies of two of his July catalogues of books. One deals with Oriental history, languages, and literature, and includes works on Oriental art and natural history; the other gives particulars of a large number of books printed during the fifteenth and sixteenth centuries, and is the first part of an illustrated catalogue to be completed in about three parts. The first part, now issued, contains some sixty facsimiles, and comprises examples of xylography in the Low Countries and Italy, and typography in Germany.

## OUR ASTRONOMICAL COLUMN.

THE LICK OBSERVATORY ECLIPSE EXPEDITION, JANUARY, 1908.—A very interesting account of the work done, and the preliminary results obtained, by the Lick Observatory-Crocker eclipse expedition to Flint Island, written by Dr. Sebastian Albrecht, appears in No. 3, vol. ii., of the Journal of the Royal Astronomical Society of Canada (pp. 115–131, May–June).

After explaining the importance of the several items in the programme prepared, and describing the various instruments, Dr. Albrecht gives an illustrated description of the eclipse-camp site, and tells of the difficulties overcome in transporting and setting up the several instruments. Errors in the ephemeris-positions of the moon led to totality commencing 27 secs. earlier than predicted, and the observed times of beginning and ending of the total phase were 9h. 22m. 20s. and 9h. 26m. 12s. G.M.T.

The equipment included a coronagraph of 40-ft. focal length, pointed directly at the eclipsed sun, and intended to photograph the details of the inner corona, a shorter instrument for photographing the coronal extensions, several spectrographs, including one with quartz lenses and prisms, two sets of four cameras for seeking any intra-mercurial planet that may exist, polarigraphs, a photometer, and Prof. Abbot's bolometric apparatus.

The photographs taken with the 40-ft. camera show about thirty streamers extending to a distance of more than one solar diameter, and about half that number extending to 1½ diameters; excellent negatives, eight in number, were obtained with the smaller coronagraph. Four good negatives, on which the linear dispersion is such that from λ 3700 to λ 5300 is thirteen inches, were obtained with the large moving-plate spectrograph, and on the one taken at the end of totality there are hundreds of bright lines, the study of which should afford a wealth of information concerning the structure and composition of the sun's higher atmosphere. From one of the smaller-scale spectrograms the wave-length of the green corona line has been determined as 5301·4. Both on these and on the spectrograms obtained with the quartz spectrograph, the shifting of the great intensity of the continuous spectrum towards the red indicates the lower temperature of the corona as compared with that of the photosphere. About twenty-five sharp lines are shown on the coronal spectrograms taken with the quartz instrument, two of which appear to be new. Dr. Perrine's examination of the photographs taken leads to the conclusion that no intra-mercurial planet of sufficient magnitude to account for the Mercury perturbation anomalies exists. Two of the photographs illustrating Dr. Albrecht's article are of the corona.

THE APPROACHING RETURN OF HALLEY'S COMET.—*Popular Astronomy* for May contains an article of general interest on Halley's comet, written by Prof. H. C. Wilson. After describing the comet's appearance at various returns since 1066, the writer compares the approximate elements, reduced to the equinox of 1910, of the orbit at the recorded apparitions from 451 A.D. onwards, and shows that those for 1910 indicate similar conditions to those obtaining in 1066, when the comet was an object of remarkable grandeur. At present the comet appears to be just beyond the orbit of Jupiter, which it should traverse about March 1, 1909, and may possibly be discovered photographically during the coming winter.

THE ORBIT OF ALGOL.—No. 5, vol. i., of the Publications of the Allegheny Observatory is devoted to a discussion of the orbit of Algol, based on observations made in 1906 and 1907 with the Mellon spectrograph; the measurable portion of the spectra extends from λ 3927 to λ 4750, and is 21 mm. in length. In this region eight lines, due respectively to Ca, He, H, Si, and Mg were selected for measurement by Dr. Schlesinger, and were measured by him and Dr. Curtiss independently, adjusted wave-lengths being employed by the latter observer. An apparent change of velocity (about −10 km.) between the observations of 1906 and those of 1907 may be due, possibly, to a change of camera lens, but it is not impossible that it is a real change in the star such as was suspected by Belopolsky. The elements and the light-curve obtained by each observer are given, and the results indicate that the light minimum lags about one and a half or two hours behind the time demanded by the velocity determinations.

THE PATH OF THE MINOR PLANET (279) THULE.—An exhaustive mathematical discussion of the orbit of the minor planet (279) Thule, by Dr. A. Wedemeyer, occupies the fifty-six pages of No. 2, vol. xxxi., of the *Archiv der deutschen Seewarte*. The special perturbations are determined by Oppolzer's method and tabulated, and the corrections derived are applied for each observed opposition of the planet from 1888 to 1906.

AN AMATEUR'S MERIDIAN INSTRUMENT.—In the July number of the *Bulletin de la Société astronomique de France* M. E. Soulié describes a simple and inexpensive apparatus which enables amateur observers to determine the meridian with very fair exactitude. It consists of a flat plate of heavy material, so supported that it hangs vertically like a plumb-line. Using the plane of this sheet to direct the line of sight, the plate is oriented to Polaris some minutes before ζ Ursæ Majoris, or δ Cassiopeiæ, crosses the sight-line. By fine adjustments, the instant when Polaris and one of these stars, preferably the latter, are in the plane of the plate together is noted, and then the plate is made to follow Polaris for exactly six minutes. At the end of this interval it is in the meridian, and may afterwards be used to observe transits or to determine local noon, &c.

## GEOLOGICAL WORK IN THE UNITED STATES.

THE work of the Geological Survey of the United States is in many regions also geographical. Bulletin No. 307 (1906), by Henry Gannett, is thus a useful "Manual

FIG. 1.—Weathering of Madison (Carboniferous) Limestone, Tongue River Canyon, Bighorn Mountains.

of Topographic Methods," reviewing in its eighty-six pages "the most approved methods of surveying as applied to the production of topographic maps." Those of us who have used the American maps on the scale of 1 : 62,500 may have wondered at the selection of this figure in place of our 1 : 63,360, or 1 inch to one mile. It is here clear, however, that the American scale is a convenient deduction from 1 : 250,000, which is employed for the maps of large areas, and which furnishes a scale of practically four miles to an inch. The thick Bulletin No. 299, by Mr. Jas. McCormick, is a second edition of the "Geographic Dictionary of Alaska," and includes 9300 names, as against 6300 published in 1902, numbers that afford "a rough indication of Alaskan growth."

Mr. N. H. Darton's "Geology of the Bighorn Mountains" (Professional Paper No. 51, 1906) is a fascinating description, very handsomely illustrated, of a region in Wyoming that has come into notice as a summer resort. There are few areas more calculated to convert the ordinary man into a keen stratigraphical geologist. Huge sections can be read off on the mountain-sides, and Cambrian, Ordovician, Carboniferous, Triassic, Jurassic, and Cretaceous deposits are represented. The Cretaceous system closes with fresh-water stages some 9000 feet thick, containing coal-seams in the upper layers, which correspond with the type of strata usually known as Laramie. Prof. R. D. Salisbury (pp. 71–90) describes the glacial geology, largely from material gathered by Messrs. Blackwelder and Bastin. Two Glacial epochs are traceable, and diminutive glaciers belonging to the later one still remain in the great chain of pre-Cambrian granite, rising 12,000 feet above the sea (see Plates xxix., xxxvi., &c.). It is claimed that glacial erosion has deepened some of the valleys by at least 700 feet. A glacial and a geological map accompany the memoir, in a pocket at the end, in accordance with the convenient plan now adopted by the United States Survey.

West of the Bighorn Mountains stretches the Bighorn Basin, on an average 5000 feet above the sea. Its geology and water-supply have been described by Mr. C. A. Fisher (Professional Paper No. 53, 1906). The basin is formed by a broad synclinal of the older strata, and its floor is occupied by Laramie beds, unconformably covered by the Eocene Wasatch clays and sandstones, as is well shown in Plate x. The ranges on the west divide this basin from the Yellowstone Park, and hot springs and geyser-deposits occur within the area now described.

Mr. N. H. Darton, the author of the memoir on the Bighorn Mountains, also describes the Arkansas Valley in eastern Colorado (Professional Paper No. 52, 1906). This is a dry region, where artesian water, held up in the Dakota sandstone, is of great economic importance, and the coloured map forming Plate xxvi. shows, by contour-lines, the altitude of the top of the sandstone above sea-level, whether exposed at the surface or concealed. The uplift of the Rocky Mountains in this region followed on the fresh-water Laramie epoch, and the rivers began to form flood-plains, and to carve out the main features of the topography in the western hills, as far back as Eocene times (p. 49). The flat alluvial fan of Miocene age attains in itself a thickness of 1000 feet.

Mr. A. C. Veatch's memoir on northern Louisiana and southern Arkansas (Professional Paper No. 46, 1906) covers a vast region, where the streams pour down from the "wolds" on the Texas and Arkansas border into the great alluvial valley of the Mississippi, which is rich in "ox-bows," on the east. The characteristic Cretaceous, Eocene, and Oligocene fossils are well illustrated, and marine conditions remained in this area until a very gradual tilting up of the north and a lowering of the coast-region set in at the opening of Miocene times (p. 44). The low mounds of fine loam, 20 feet to 100 feet across and 3 feet to 5 feet high, which dot the fluviatile plains

FIG. 2.—Residual Glacier in cirque, Cloud Peak, Bighorn Mountains.

of the Louisiana and Texas coast, provide a very interesting discussion (p. 55). They are not forming under existing conditions, and may have been due to ancient wind-action, or even to termite ants, which subsequently passed away in the face of climatic changes. Some 250 pages of the paper are devoted to the underground water-supply of the region, and various methods of well-drilling are described and illustrated.

Bulletin No. 298 contains a record of deep wells drilled during 1905, particulars of which are collected by the Survey, while geological advice is freely given to well-sinkers who ask for it, and the difficulties likely to be encountered are pointed out. Bulletins Nos. 279, 286, 304, 317, and 318 (1906–7) deal with various coal and oil districts. Indications of underground structure are given on the maps, and in No. 318 transparent sheets with contours are supplied, to be laid over the ordinary maps, and indicating the depth at which a particular oil-bearing bed may be encountered. No. 320, by Messrs. S. F. Emmons and Irving (1907), contains important additions to what has been previously published on the ores of Leadville, Colorado; the Downton district serves as the particular instance. Waters originating during the cooling of igneous masses are here put into a prominent place as ore-bearers (p. 66), though at Leadville the concentration of ore "in exceptionally rich bodies has come about through the agency of surface waters" (p. 72). Bulletin No. 297, by Mr. M. R. Campbell (1906), treats of another asset of Colorado, the Yampa coalfield, north-west of Leadville, where the coals are in the Montana stage of the Upper Cretaceous strata. Mountain-building processes have converted much of this "sub-bituminous" coal into coal of a higher grade, while metamorphism by igneous intrusions has given rise in parts to anthracite. Mr. Darton, in the Bighorn memoir mentioned above, describes coals, including a 7-feet seam, still higher in the Cretaceous system to the north of Yampa.

Bulletins No. 303 (S. Nevada, 1907) and No. 295 (Yukon-Tanana, Alaska, 1906) are concerned with gold-mining; the topographical map in the latter is regarded as the most important feature, and similar sheets are being rapidly pushed forward on the 1 : 250,000 scale.

Petrographers and chemists will be grateful to the Survey for Bulletin No. 305 (1907), by Mr. W. F. Hillebrand, on "The Analysis of Silicate and Carbonate Rocks." This will take the place of the well-known No. 176. Attention is given to the question of porosity (p. 38), which is so important a factor in building-stones, and the rocks composed of carbonates are now for the first time specially considered. Mr. T. N. Dale describes (No. 313, 1907) the "Granites of Maine," the foundation of a very important industry. The striking sheet-structure of granite is discussed (p. 30), and stress is laid on its possible origin by compressive strain. Dark knots in the granite due to segregation are distinguished from the inclusions that also occur (p. 50). Examples of the use of the granite in carved work are shown in the illustrations. Messrs. Emerson and Perry (Bulletin No. 311, 1907) describe the "Green Schists and Associated Granites and Porphyries of Rhode Island." Interesting features of contact-metamorphism occur, including the brecciation of a micro-granite by a later granite magma, and the production of interstitial films of biotite and magnetite between some of the closely adjacent fragments (p. 68). Explosive action at the top of the dome seems to have blended this breccia with a true Carboniferous conglomerate at the surface. A new locality for riebeckite is here given (p. 53).

The only palæontological bulletin received by us is No. 292 (1906), by Mr. R. S. Bassler, on "The Bryozoan Fauna of the Rochester Shale." This shale is a member of the Niagaran series (Silurian, *i.e.* Upper Silurian), and is well displayed in the Niagara gorge. The conditions of its deposition seem to have been admirably suited for bryozoan life, and types abound which are not represented conspicuously in contemporary American strata elsewhere. As "compared with the Ordovician types, the noticeable features are the predominance of the Cryptostomata and the decline of the Trepostomata" (p. 2). The author (p. 8) asks English workers to undertake a comparison of the Rochester bryozoa with those which have "received but little study" in the Buildwas beds of the Wenlock series. The thirty-one excellent plates in this bulletin will prove helpful to anyone who will accept this friendly challenge. Even our Carboniferous bryozoa have been much neglected during the last quarter of a century.

Before we pass to the surveys of separate States, we must mention Mr. Weeks's continuation of the "Bibliography and Index of N. American Geology and Mineralogy" (Bulletin No. 301), which covers all work done from 1901–5 inclusive.

The Wisconsin Geological and Natural History Survey sends us three bound Bulletins. No. xv. is on the "Clays of Wisconsin," by Dr. H. Ries (1906), and treats of the characters of clays in general from an economic point of view, as well as giving details of those worked within the State. Tests of clays and bricks have been made for this report. On p. 213, in an appendix on "Molding Sands," we note a formula for determining the pore-space of a sand which would give far too low a result. "Grains" should, we presume, read "grams" in this passage, and we take it that the formula intended is $100(Vd-W)/Vd$, if a percentage is required.

FIG. 3.—Sheet-structure in granite, Sullivan, Maine.

Bulletin No. xvi. is a volume of nearly 700 pages, with folded maps, by Mr. S. Weidman, on the "Geology of North Central Wisconsin" (1907). About 75 per cent. of the area is occupied by intrusive igneous rocks, which are fully described, and which have sometimes been crushed and converted into schists. The troctolites and nepheline-syenites will attract petrographers, and there are interesting intermixtures of granites and diorites (Plates xxii. and xxiii., for example), and gneissose "nepheline-pegmatites," the banding in which is due to original flow. On p. 308 the new variety of pyrochlore, called marignacite, is described. The account of the glacial features of the area is prefaced by a general sketch of North American glaciation, and the full and admirably illustrated chapters on the surface-configuration ought to interest every educated dweller in the State. References, however, are required throughout this volume from the illustrations to the text. Bulletin No. xvii. is on the "Abandoned Shore-lines of Eastern Wisconsin," by Mr. J. W. Goldthwait (1907), and is a study of the development and passing away of the lakes and lake-extensions associated with later Glacial times. The evidences of warping in the shore-terraces through earth-movement are of special interest. Mr. E. C. Harder has contributed a study of the relations of streams and joint-systems to the Bulletins of the University of Wisconsin (No. 138, 1906), in which the south-western area of the State is dealt with. The maps, however, do not at once carry conviction, owing to the obvious influence of large topographic features on the courses of many of the smaller streams.

The Iowa Geological Survey issued its fourteenth annual report (for 1905) in 1906, a thick volume giving much information on the economic and general geology of the State. The descriptions, fully illustrated, are published county by county, and the stratigraphy concerns Ordovician and Silurian rocks especially. Next in interest to these come the glacial drifts, often overlain by loess of the usual problematic origin. The value of this loess as a soil-provider is justly dwelt on on p. 393. The huge boulders from northern Minnesota and Wisconsin, often of red granite, remind one of those of Holland and north Germany, and similarly serve as quarries for the farmer. The scope of this survey covers forestry and the observation of the local flora.

The Maryland Geological Survey continues its well-printed series of volumes with one on the Pliocene and Pleistocene deposits (1906), one on Calvert County (1907), and one on St. Mary's County (1907). In the county volumes we again note how geological surveys in the United States tend to become natural history surveys, with the view of the application of all branches of observation to local education and the local industries. This is a return, and we venture to think a welcome one, towards the broad and wholesome "statistical surveys" of the eighteenth and early nineteenth centuries; and surely the climate, plant-associations, and human activities of a district are so closely united with topography and geology that a united survey under one scientific department seems the only rational way of studying a political division. A certain amount of repetition, even in diagrams and illustrations, is, of course, inevitable, if each county is separately dealt with, but local knowledge is no doubt enlarged by such a system. The palæontological studies given in the Pliocene volume show that so-called "pure" science is in no danger of being eclipsed. The superficial deposits of Maryland (called "surficial" in the memoir) are "the last of a long series of unconsolidated beds which began to be deposited in Lower Cretaceous and possibly Jurassic time, and have continued on with interruptions down to the present" (p. 136). Five systems of terraces are traced in the coastal plain, the highest being the oldest. These are uplifted terraces of marine deposition, and represent the seaward edges of submarine platforms, successively constructed out of the products of coast-erosion and of materials swept by currents against the shore (p. 108). It is interestingly urged that "the Atlantic seaboard has been repeatedly elevated when loaded and depressed when lightened" (p. 137).

The domes of folding in Maryland, its Upper Devonian fauna, its climate, and the historical origin of its counties are dealt with in the Johns Hopkins University Circular, "Notes from the Geological Laboratory" (July, 1907). The work of the University, the State Survey, and the general United States Geological Survey seem happily combined (p. 2) in the interests of research.

Dr. J. A. Udden publishes in the Bulletin of the University of Texas, No. 93, 1907, an account of the "Geology of the Chisos Country, Texas," which is of the more value since the Geological Survey of that State has been discontinued.

Lastly, workers in Silurian fields will be interested in Mr. E. M. Kindle's paper on the "Occurrence of the Silurian Fauna in Western America" (*Amer. Journ. Sci.*, vol. xxv., February, p. 125). "Silurian" is used in the restricted sense now common in England, and beds of this age are traced in the Wasatch Mountains of Utah and Alaska. *Conchidium Knightii* is large and abundant on Kuiu Id. in S.E. Alaska, though not hitherto known from the United States. Another old acquaintance, *Pentamerus oblongus*, is abundant in the Utah fauna.

G. A. J. C.

## THE ROYAL SANITARY INSTITUTE.

THE annual congress of the Royal Sanitary Institute was held at Cardiff last week. Many interesting papers were read, and several useful discussions were arranged. A large proportion of the papers fittingly dealt with practical and demonstrative matters arising out of the duties and work of sanitary and educational authorities and the officials who serve them. There was a dearth of original contributions of a scientific nature, but those contributions which appear to call for special reference are the following:—

Dr. W. G. Savage read a paper upon "The Examination of Sausages and their Hygienic Preparation." While sausages are usually composed of good meat, finely minced and mixed with flour, spices, and flavouring agents, such as salt, pepper, and sage, there are no definite guiding standards in this country either as to their composition, the presence and amount of preservatives, or their bacterial content. Hitherto there does not appear to have been any investigation dealing with the bacteria of sausages, and Dr. Savage has recently examined twelve different samples, purchased on the open market, in order to see how far typical excretal organisms are present in them. Most of the sausages examined were quite recently made, and the results show that *Bacillus Coli* of definite excretal type were always present in large numbers, whereas the ordinary musculature, bread, and other constituents of sausages in their pure state do not contain *B. Coli*. Although this bacillus is the distinctive organism of excreta, and the fact of its presence in considerable numbers in sausages is not a nice matter to contemplate, it must be realised that the bacillus referred to is found in the intestines and given off from the dejecta of animals generally. These and other facts referred to by Dr. Savage call for the framing of some standard by which the purity and wholesomeness of these articles of food can be judged.

An instructive paper was presented by Mr. H. Percy Boulnois upon "The Utilisation of Residuals from Refuse Destructors," and two other papers were contributed to the congress upon the same subject. The amount of refuse produced in a town in this country is about a quarter of a ton per head of population per annum, and after this has been cremated in a destructor, the residual clinker represents from 25 to 33 per cent. of the refuse burnt. Of the many methods which have been devised for utilising this material, reference was made to a very recent method which involves the use of the lightning dust crusher for converting furnace clinker into the form of poudrette. The lightning dust crusher consists of a comparatively small steel case containing four or six steel hammers, each weighing about 50 lb. The axle on which these hammers hang is rotated by machinery at the rate of about 1000 revolutions per minute. The machine can be fed at the rate of four tons an hour, and the poudrette escaping finds a market, as a manure, at 2*s*. 3*d*. per ton. It is quite inoffensive to the smell, and recently Mr. H. J. Coles, the surveyor of Market Harborough, has, by mixing the poudrette with tarry compounds, made very serviceable fuel briquettes, with a calorific value amounting to one-third that of the best coal.

Mr. Reginald Brown had some experiences to offer with reference to "The Surface Treatment of Roads in Relation to Dust Laying." He recommended the use of oil-tar, which is a by-product of the manufacture of gas from oil, and varies in its composition according to the temperature of production, the nature of the retort or producing plant, and of the oil used. The lack of uniformity in composition, however, does not seriously affect its suitability for road treatment. From extended experience it has been found that four dressings are required for each watering season, and that on an average one gallon will cover ten superficial yards. The cost of "surfacing" a road with oil-tar averages one penny for four dressings (no grit being required for covering), and this works out at 58*l.* 13*s.* 4*d.* per mile per watering season, a figure which contrasts favourably with the cost of tar painting and approximates very closely to that of watering. In some instances the material is applied hot, but Mr. Brown has used it upon all the streets of the Southall-Norwood Urban District in the cold state by means of an ordinary watering cart, with excellent results. The appearance of the road treated with oil-tar is that of a newly-laid wood pavement, and the odour given off is similar. It is his opinion that the use of both coal-tar and oil-tar will become pretty general, the use of oil-tar being adopted where it can be obtained, and coal-tar where oil-tar is not manufactured. The employment of "akonia," calcium chloride, "halmite," and "pulvicide" is also considered in the paper. But oil-tar is shown to possess certain advantages, more especially of economy, over other methods.

Mr. W. D. Scott-Moncrieff contributed a paper upon "Some Recent Experiments on the Biolysis of Sewage." The immediate objects of his investigation were to discover what periods of hydrolysis gave a sufficient standard of purification with measured conditions of flow, and the experiments are claimed to have shown, for the first time, not only the behaviour of the sewage in varying circumstances of sojourn, &c., in the septic tank, but also to what extent a well-matured filter working under proper conditions is capable of dealing with the polluting organic matters under widely varying conditions, as regards different periods of hydrolysis. It should be noted, however, that the author points out that the results he has obtained are strictly confined to the special conditions that produced them, and that they do not justify any generalisations.

A noteworthy paper upon "The Limit of School Children's Capacity for Attention" was read by Prof. W. Phillips. After referring to the various experimental inquiries into this question, which have involved the use of various forms of Mosso's ergograph, or fatigue recorder, and Griesbach's æsthesiometer, and many experiments designed to test the rate of deterioration in mental work done at different times of the day and on different days of the week, Prof. Phillips discussed the useful results which all this work has led to. His conclusions are as follows:—

(1) The various tests seem to agree on one point, viz., that during an ordinary school session children can maintain a more even degree of attention, if one or two intervals of rest are included. Where two of ten minutes each can be arranged, more advantage is gained than from one of twenty minutes. (2) The tests seem to agree, too, in showing that a child's attention wanes more rapidly in the afternoon than in the morning. Therefore those teachers who have been accustomed to place the less taxing subjects of instruction in the afternoon seem justified. (3) The various branches of mathematics seem, *ceteri paribus*, to make a greater demand on the attention than most other subjects. This result has long ago been anticipated by those teachers who place mathematics early in the morning session. (4) Gymnastics is not of necessity a mentally recuperative subject, some of the tests proving that children were often tired after a lesson in it. (5) In connection with the discussion of the extent of the fatigue caused by gymnastics, it soon becomes obvious that the results do not depend on the nature of the exercise alone, but also on the teacher. If the latter is a strict disciplinarian, the fatigue may be of a pronounced character. (6) It is clear that attention depends on numerous factors, such as the age, health, and nutrition of the child, the temperature and ventilation of the class-room, &c. But above all it depends on the child's training and education.

## *RECENT METEOROLOGICAL PUBLICATIONS.*

THE report of the second Norwegian Arctic Expedition of 1898–1902,[1] edited by Dr. H. Mohn and published at the expense of the Fridtjof Nansen fund for the advancement of science, forms a valuable addition to the meteorology of a little-known region of the earth's surface.

[1] Report of the Second Norwegian Arctic Expedition in the *Fram*, 1898–1902. No. 4. Meteorology. By H. Mohn. (Kristiania: Published by Videnskabs-Selskabet i Kristiania, 1907.)

The *Fram* left Christiania on June 24, 1898, and sailed, *via* Godhavn, Upernivik, Foulkefjord, and Cocked Hat, to the first winter quarters, which were reached in September. As the methods of observation were different when the ship was anchored from when she was under way, the results are given separately, and as those obtained at the winter quarters are most complete they are given in part i.

The positions of these winter quarters and the length of stay at each are shown in the following table:—

| Place | Lat. N | Long. W. | Duration of stay. |
|---|---|---|---|
| Rice Strait ... | 78° 45′·7 ... | 74° 56′·5 ... | 1898, Sept. 19 to 1899, July 24 |
| Havnefjord ... | 76 29·4 ... | 84 3·7 ... | 1899, Oct. 23 to 1900, Aug. 9 |
| Gaasefjord I. ... | 76 48·9 ... | 88 39·5 ... | 1900, Sept. 18 to 1901, Aug. 12 |
| " II. ... | 76 39·8 ... | 88 38·3 ... | 1901, Sept. 6 to 1902, July 21 |

The interval August 12 to September 6, 1901, was spent sailing about in the Gaasefjord.

Up to June, 1899, Dr. Johan Svendsen—the physician of the expedition—who had taken part in the examining and comparing of the instruments before they left Norway, was the meteorologist-in-chief, but his lamented death in that month robbed the expedition of his further invaluable services.

The pressure observations were made with the same barometer—a Kew standard Adie 850—throughout, and readings were taken every two hours from midnight to midnight. A small number of records were, from one cause and another, omitted, but the gaps have been filled in by the interpolation of readings from a Richard barograph. In the tables the values, reduced to standard temperature, barometer, gravity, and sea-level, are given for the bi-hourly readings each day; daily and monthly means, and the monthly means for each even hour, are also shown. The mean pressures for the months exhibit a regular annual period, with a chief maximum in March, a secondary maximum in November, a principal minimum in August, and a secondary minimum in January. The range of pressure is 11·8 mm., and the yearly mean pressure for the whole region is 761·40 mm. Other tables summarise the lowest and highest pressures recorded, and the differences between the mean highest and mean lowest pressures in each month are given. The oscillation of pressure is shown to be greatest in February and least in August, greatest in winter, least in summer.

Owing to the rolling of the *Fram* only a few of the thermometers came back safely to Norway, but there is sufficient evidence on which to base the discussion of errors. The reduced values for temperature are tabulated in much the same form as those for pressure, and the summaries show that during the "dark season" (November, December, January), when the sun remains below the horizon, the diurnal variation vanishes entirely. The daily range of temperature shows an annual period with a maximum (3°·47 C.) in April; during the three summer months it is practically stationary at 1°·7 C. to 1°·8 C. The respective effects of clear and overcast skies on the temperatures recorded are shown very clearly (p. 113). With a "clear sky" in the months October to January, the daily minimum occurs in the day hours and the maximum at night, but with an "overcast sky" the ordinary daily period obtains in every month. Dr. Mohn suggests that the investigation of air temperatures in the Arctic and Antarctic regions deserves greater attention, the final results of which would probably throw considerable light on the question of radiation from and to the earth in the lower atmosphere.

The lowest temperature recorded by the expedition (−51°·3 C.) was obtained on January 20, 1901, a year that was marked by unusually low temperatures, and the highest (13°·3 C.) was recorded on July 9, 1902; thus the absolute range becomes 64°·6. In the mean there are about thirty-four days per annum when the temperature falls below −40°; February is marked by exceptionally high maximum temperatures, especially in 1900.

The other meteorological factors, wind, storms, clouds, precipitation, &c., are dealt with by Dr. Mohn in a similarly comprehensive fashion, but enough has been said to show that in this volume we have data of unique value which should prove of great service in current meteorology. The work has obviously been done with conscientious care and thoroughness; the only pity is that the period for which observations are available is so brief.

Another recent addition to meteorological science appears as a Harvard publication,[1] and deals with the observations made at Arequipa during the years 1892–5. Earlier observations were made at Arequipa during 1888–90, and the results appeared in vol. xxxix. of the Annals. The work was resumed in 1891, but as the records thereof are incomplete none earlier than those of 1892 has been included in the present publication.

The area dealt with in this volume differs, of course, in most respects from that treated by Dr. Mohn, the latitude of Arequipa being 16° 22′ 28″ S., but the same careful observation and full discussion are common to the two volumes. The Arequipa station is a rather peculiar one, inasmuch as it is situated at an altitude of 8040 feet above sea-level, although only 350 feet above the plaza of Arequipa city, some two miles distant. Several peaks some 20,000 feet in height lie within ten to twenty miles of the station, and have been usefully employed in the estimation of the heights and extents of clouds. The results and summaries are given in a series of twenty-four tables, and are too comprehensive in detail and suggestion to be dealt with at length here, but one or two side issues may be noted.

In taking pressure observations, both mercurial barometers and a barograph were employed, and it was noticed that the latter gave a diurnal range consistently smaller than that given by the mercurial barometer; these differences are to be discussed, at length, in a subsequent publication. Barometer readings were taken at 8 a.m., 2 p.m., and 8 p.m.

Similarly, a smaller daily range was indicated by the thermograph than by the thermometer, and the former shows a distinct lag, particularly noticeable at the 8 a.m. readings.

The records of cloudiness were obtained with a sunshine recorder between 6 a.m. and 6 p.m. during the period January, 1892, to June, 1893, but for dates after that the hourly means for sunshine recorder and pole-star recorder are given, thus including the twenty-four hours of each day. The results with the latter instrument agree with eye-observations, but, owing to the sensitiveness of the blue paper employed, the sunshine recorder gives exaggerated values for the clearness of the sky; the character of the cloud was indicated by the numbers 1 to 5, 1 representing thin and 5 representing dense cloud, and it seems probable that only clouds of characters 3 to 5 were registered by this instrument.

W. E. ROLSTON.

## THE AMERICAN ASSOCIATION OF MUSEUMS.[2]

FOLLOWING the example of the museums of the United Kingdom, the officials of similar institutions in the United States have inaugurated a movement which is to be known as "The American Association of Museums." It has been organised with that attention to detail and breadth of view which specially belong to our American cousins, giving full promise of successful development. The pioneer work was carried out by Dr. W. J. Holland, director of the Carnegie Museum, Pittsburg, Pa, who issued invitations to the heads of a number of the leading museums of America, and others likely to be interested in the formation of such an association, to attend a preliminary meeting to be held at the American Museum of Natural History, Central Park, New York, on May 15, 1906. A cordial response was made to this invitation, more than seventy delegates attending, while nearly fifty others signified by letter their adhesion to the scheme. Practically all phases of museum work were represented from every State in the Union. Dr. Hermon C. Bumpus was elected president, with Dr. George A. Dorsey, Field Museum of Natural History, Chicago, as secretary. Officers were appointed, and a committee of organisation was authorised to draw up a constitution. This is mainly based on that of the Museums Association established in England nineteen years ago, with one essential difference, for while the English association is primarily one of institutions, the full members being museums, with associate members to include individuals interested in museums, the American association consists of active, associate, sustaining, and honorary members. The active members consist of persons actively engaged in the work of museums, and they alone are eligible to hold office. Sustaining members are museums, with the right to vote through the chief executive officer. Associate members need not be engaged in the work of museums, and they have no vote.

Various papers on practical museum subjects were read at this meeting, but they are not published in this volume, which only gives the general proceedings and titles of the papers submitted. Six life members, 135 active members, and twenty-six sustaining members were enrolled, which shows how heartily the scheme has been accepted, while a strong financial position was at once assured, the subscriptions amounting to 592 dollars, and after deducting the necessary expenses the substantial balance of 472 dollars remained.

By invitation of the trustees of the Carnegie Museum the second annual meeting was held at the Carnegie Institute, Pittsburg, Pa, on June 4–6, 1907, and the present volume is chiefly occupied with the papers read at that meeting. Dr. Holland gave a concise but amply descriptive account of the purpose of the Carnegie Institute, which shows that in America Mr. Carnegie realises the equal importance of museums with libraries in the scheme of general knowledge and human progression, and does not there restrict his generous impulses to the latter institutions as he does in our country. About sixty members were present at this second conference, when various resolutions affecting the status and future work of the association were discussed, the principal one relating to the form in which the proceedings should be published. There were three suggestions made:—(1) that the papers should be published in one of the American scientific journals; (2) the issue of a separate annual volume; (3) a periodical of their own at more frequent intervals dealing with museum subjects generally. The latter suggestion appeared to find most favour, though there were two important difficulties raised, viz. the cost and the selection of an editor willing to undertake the work. The question of cost showed great divergence of view, from less than 1000 dollars to many thousands. The same difference of opinion prevailed in the English Museums Association when they started their *Museums Journal* seven years ago with only about 100*l*. in hand, but experience has shown that the increased income from it has more than covered the cost. Speaking from an intimate personal acquaintance with the editorial work of that journal, we would strongly advise no American curator to undertake similar work lightly.

The titles of the papers will show the wide scope of museum work, and how wisely the association has confined itself to the subjects within its legitimate province. We suggest that a table of contents at the beginning of future volumes would greatly facilitate reference and add to the use of the volume. Mr. Henry L. Ward submitted papers on "The Labelling in Museums," "The Aims of Museums," with special reference to his own museum at Milwaukee, and "The Exhibition of Large Groups in Museums." Dr. Benjamin Ives Gilman, of the Museum of Fine Arts, Boston, dealt with "The Triple Aim of Museums of Fine Art" in his customary comprehensive manner. The other papers published include:—"Some Instructive Methods of Bird Installation," by Frank C. Baker; "A New Method of Mounting Ethnographical Objects," by Dr. E. S. Morse; "Installation of Swinging Frames," by W. M. R. French; "Museum Records," by Paul M. Rea; "The Evolution of Museums," by F. A. Lucas; "The Work of a Children's Museum," by Miss Anna B. Gallup, and other contributions on museum administration and management, many of the papers being well illustrated. There is also an interesting plate of the Diplodocus, with the members of the association gathered about it.

E. HOWARTH.

[1] "Harvard College Observatory Annals," vol. xlix., part i. Peruvian Meteorology, by Solon I. Bailey. Observations made at the Arequipa station, 1892–5.

[2] Proceedings of the American Association of Museums, vol. i. (Pittsburg, Pa, 1908.)

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

EDINBURGH.—Prof. J. Walker, F.R.S., has been elected to the chair of chemistry in the University in succession to Prof. A. Crum Brown, F.R.S.

LIVERPOOL.—Prof. Salvin-Moore has resigned the directorship of the Liverpool Cancer Research Committee, and accordingly vacates the professorship of experimental cytology in the University on September 30.

A VOLUME about Canada in Sir C. P. Lucas's "Historical Geography of the British Colonies" will be published shortly by the Oxford University Press. The author, Prof. H. E. Egerton, confines himself to history. Mr. J. D. Rogers, who wrote "Australasia" for the same series, will deal with the geography of Canada in another part.

THE following appointments have been made at University College, London:—Mr. H. M. Hobart to the newly-created lectureship in electrical design; Dr. A. W. Stewart to the lectureship in stereochemistry for the session 1908–9; Mr. G. C. Mathison to the Sharpey research scholarship in physiology; Mr. W. F. Stanton to be demonstrator in the department of applied mathematics; and Mr. H. S. Bion to be demonstrator in the department of geology.

THE Association of Technical Institutions held its summer meeting on July 17 at the Franco-British Exhibition. The chair was taken by Sir Horace Plunkett and Dr. Friedel, head of the Information Bureau of French Education, who gave an address on the French educational system. Dr. Friedel said that the most interesting development of higher education in France is that at the Universities pupils can get special instruction in their various technical pursuits, including agriculture and watch-making, so that technological education now goes from the elementary stage right up to the University. Municipalities do a great deal for their Universities; they give money, found chairs, build laboratories, and endow all kinds of institutions connected with the Universities. Perhaps the time will come, he said, when English towns will do more than they do at present in that direction. Sir Philip Magnus also spoke.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Mineralogical Society**, June 16.—Prof. H. A. Miers F.R.S., president, in the chair.—A nickel-iron alloy ($Fe_5Ni_3$) common to the meteoric iron of Youndegin and the meteoric stone of Zomba: L. **Fletcher**. In the case of the Zomba meteoric stone, the gradual increase of nickel in the residue after repeated extraction of the nickel-iron with mercuric ammonium chloride was previously attributed to rusting. It is now explained by the presence in the nickel-iron of a component not easily affected by the mercuric solution and containing 38·50 per cent. of nickel. This component is identical with the "tænite," containing about the same percentage of nickel, which was separated from the Youndegin iron by its insolubility in dilute hydrochloric acid.—Kaolinisation and other changes in West of England rocks: F. H. **Butler**. The author pointed out that the gaseous emanations of a granitic magma, which are carried upwards and discharged externally, gradually bring about considerable pneumatolytic changes. Notable among these are increased vesicularity in the quartz of the peripheral part of granitic intrusions and their offsets, the elvans, also the assumption by that mineral of the idiomorphic form, and the production of tourmaline. The occurrence of tourmaline in rocks exemplifying various stages in metasomatism indicates long-continued supply of boron compounds from abysmal regions. The primary, usually brown, tourmaline in the altered acidic rocks is commonly found to have been eroded, doubtless owing to alkalinity of the kaolinising solution, before dekaolinisation and the consequent formation of acicular schorl ushered in a final deposition of quartz. The view of Prof. Vogt and other authorities that kaolinisation was effected by the rise of solutions of carbon dioxide from among calciferous rocks receives support from the occurrence of calcium sulphate in underground waters and of numerous calcium compounds in mineral veins and lodes. The unchanged condition of some topaziferous granite is one of various indications that the action of hydrofluoric acid on rocks has been low down rather than superficial. It or hydrofluosilicic acid appears to have played a part in the following sequence of events in the west of England:—(1) Decomposition of deep-seated calcite-bearing rocks, and consequent kaolinisation of neighbouring granite by evolved carbon dioxide; (2) local and variable dekaolinisation, fluorisation, and tourmalinisation of china-clay rock and china-stone by borated waters carrying dissolved fluor-spar, resulting in the formation of schorlaceous rocks and greisen. (3) Lastly, supply to the metasomatised rocks of tinstone and wolfram from solution, and then of silica. The author concluded with a brief summary of facts subversive of the popular notion that the kaolin of commerce is the result of subaërial action upon granite.—Schwartzembergite, and the drawing of light-figures: G. F. Herbert **Smith**. The author described the crystals occurring on three specimens in the British Museum, the locality being San Rafael, Chili. They are formed of four low pyramids, above and below, eight in all, with nearly square contour, the angle from the centre averaging 20°, with range 15°–25°, and simulate tetragonal symmetry; steep pyramids are occasionally present also. The mean refraction is 2·350. The optical characters are remarkable; through each pyramid face appears in convergent light a biaxial interference-figure ($2E = 16°$) with negative birefringence, the axial plane being parallel to the edge of the contour, but through intermediate sectors appears another biaxial interference-figure with larger angle ($2E = 33°$), the axial plane being in this case radial; the number of different directions of single refraction in the crystal is, however, only four. The pyramids give with pin-hole object a continuous band of light. Since there was no well-defined image from which to measure, it was necessary to draw these figures direct on to a projection. The author described a camera-lucida attachment for the goniometer which would allow of the preparation of projections of different sizes and of the relative variation required by the distortion in a projection.—The chemical composition of seligmannite: G. T. **Prior**. The results of two analyses show that this new mineral from the Binnenthal is a sulph-arsenite of copper and lead ($PbCuAsS_3$) corresponding to the sulph-antimonite, bournonite, with which it is crystallographically similar.

### DUBLIN.

**Royal Dublin Society**, June 16.—Prof. Sydney Young, F.R.S., in the chair.—On the quantitative spark spectra of titanium, uranium, and vanadium: Dr. J. H. **Pollok**. Tables were given showing the rate of disappearance of the various lines of the spectra of each element on dilution, and reproductions of the spectra were shown in which the most characteristic and persistent groups of lines were marked. A second paper, "On the Spectrographic Analysis of a Sample of Commercial Thallium," illustrated the most convenient method of using quantitative spectra for the identification of small quantities of impurities in metals or minerals.—The secondary $\beta$ radiation excited by $\gamma$ rays: F. E. **Hackett**. The method used was to measure the ionisation produced by the $\beta$ radiation emitted from the back of a plate when $\gamma$ rays were incident on the front, care being taken that the intensity of the $\gamma$ rays issuing from the different plates was the same. The plates were thick enough to absorb the $\beta$ rays present in the incident pencil, so that the secondary radiation measured was due solely to $\gamma$ rays. For substances of atomic weight less than 130, the secondary radiation measured in this way is almost constant, and equal to 70 on the scale used. For higher atomic weights the secondary radiation increases, reaching the value of 100 for lead and 120 for uranium. The paper contains a theoretical discussion of the subject, deducing the radiating power per unit volume and per atom of the substances examined when subjected to the same intensity of $\gamma$ rays. The paper also contains some measurements of the penetrating power of the secondary rays.—The occurrence of deposits of unbroken marine shells at high levels on the Curraun Peninsula, co. Mayo: T. E. **Gordon** and Prof. A. F. **Dixon**. The authors described several deposits of unbroken marine shells occurring in relatively enormous numbers at the foot of cliff-like terraces of the Old Red Sandstone, lying mostly in recesses beneath overhanging rocks or deep in narrow clefts. The shells were found at heights of 100, 300, and 700 feet above sea-level. The unbroken condition of the shells, their enormous number, their presence in deep, horizontal, narrow rock clefts, and the fact that they were found so far as half a mile from the sea coast, high on the side of a barren mountain, led the authors to the conclusion that their presence was not due to human agency or to birds. The appearances suggest that the shells, which are all of littoral species, were left behind on a rocky coast by a receding sea. In spite of the geological difficulties of such a suggestion, the authors had no other to offer.—Curious water-worn markings on rocks at Doughbeg, co. Mayo: T. E. **Gordon** and Prof. A. F. **Dixon**. Rounded and horse-shoe shaped markings regarded by the authors as due to the action of water containing sand or grit pouring down a smooth, sloping rock surface on which were a number of projecting pieces of vein quartz.—Dry rot of the potato tuber: Dr. G. H. **Pethybridge** and E. H. **Bowers**. The authors dealt with a case in which the dry-rot fungus *Fusarium Solani* was the cause of considerable trouble. Inoculation experiments were carried out with this fungus (including a pure culture of it) which show that it is a true parasite.—An investigation of the connection between band and line spectra of the same metallic elements: Prof. W. N. **Hartley**.

PARIS.

**Academy of Sciences**, July 13.—M. Bouchard in the chair.—Notice on Alphonse Peron, correspondant of the Academy, whose death occurred at Auxerre, July 2, 1908: M. **Douvillé**.—A hypothesis by means of which the variations of the radius vector of the sun can be obtained, without necessitating the consideration of the sun's apparent diameters: J. **Boussinesq**.—The lava from the recent eruption of Etna: A. **Lacroix**. Details are given of the petrographical study of different lavas: three chemical analyses of products of different origin show very slight differences.—A hæmogregarian from *Morelia spilotis*: A. **Laveran**. A description of an organism apparently identical with *H. Shattocki*, with ten diagrams showing various stages of development.—The action of metallic oxides on the primary alcohols: the case of irreducible oxides: Paul **Sabatier** and A. **Mailhe**.—The oxides MnO, SnO, and CdO give hydrogen and the aldehyde at 340° to 350° C., but the action is less rapid than with reduced copper. The blue oxide of tungsten and the oxides of aluminium and thorium give ethylene and water. Many oxides (chromium, silica, titanium, zinc, &c.) act catalytically in both ways, aldehyde, hydrogen, ethylene, and water being produced.—The partial eclipse of the sun of June 28, 1908, observed at the Observatory of Ebra (Spain): M. **Cirera**. The actinometric observations were hindered by clouds, which rendered uncertain the determination of the time of the first contact.—The eclipse of the sun of June 28, 1908, observed at the University of Strasburg: Robert **Jonckheere**. The observations of the times of the first and second contacts were satisfactory.—Observation of the partial eclipse of the sun of June 28, 1908, at the Observatory of Bordeaux: F. **Courty**.—The history of lunar relief: P. **Puiseux**.—Certain systems of differential equations: Edmond **Maillet**.—Canonical products of infinite genus: Arnaud **Denjoy**.—Positive electrons: Jean **Becquerel**. In a previous note the author has described certain phenomena which appear to indicate the existence of positive electrons. In the present paper other possible explanations are examined in detail, but found to be experimentally untenable; the hypothesis of the formation of positive electrons thus remains the best available to explain the observed phenomena.—Remarks on a note by M. Tissot, "On the Use of Detectors sensitive to Electrical Oscillations, based on Thermoelectric Phenomena": Edouard **Branly**.—The mechanism of synthesis of rings containing nitrogen.—The action of ethyl pyruvate upon paratoluidine: L. J. **Simon**.—Sparteine. The conversion of *iso*sparteine into α-methylsparteine: Amand **Valeur**.—Researches on some acid sulphates of potassium: L. **Arzalier**.—Osmotic pressure and the Brownian movement: Jacques **Duclaux**.—The physico-chemical analysis of wines: Paul **Dutoit** and Marcel **Duboux**. The determination of the sulphates, total acidity, and tanning materials of a wine can be done in an hour by measuring the changes in the electrical conductivity caused by the gradual addition of baryta solution.—The stigma-bearing nucleus and pollinisation in *Saxe-Gothea conspicua*: A. **Tison**.—The influence of the concentration of solutions of some sugars on respiration in plants: A. **Maige** and G. **Nicolas**.—The grafting of some varieties of beans: Lucien **Daniel**.—The mechanism of the distribution of products possessing smell in the plant: Eug. **Charabot** and G. **Lalone**.—The chemical study of the ripening of *Lycopersicum esculentum* (tomato): F. M. **Albahary**. As the tomato ripens, the amounts of organic acids, sugar, starch, and nitrogenous materials other than proteids increase, whilst the proteids and cellulose diminish.—The influence of amyl nitrite on the red globules of the blood: Gr. **Flavu**.—The *rôle* of the malic acid fermentation in vinification: A. **Rosenstiehl**.—The physiological *rôle* of the leucocytic granulations: M. **Kollmann**.—The discovery of fossil plants in the volcanic earths of Aubrac: Ant. **Lauby**.

## CONTENTS.

THURSDAY, JULY 30, 1908.

## A TREATISE ON CHEMISTRY.

*A Treatise on Chemistry.* By Sir H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S. Vol. ii., The Metals. New edition, completely revised by Sir H. E Roscoe and Dr A. Harden. Pp. xvi+1436. (London: Macmillan and Co., Ltd., 1907.) Price 30s net.

SIR HENRY ROSCOE is to be congratulated on having completed a new edition of that portion of Roscoe and Schorlemmer's well-known "Treatise on Chemistry" which deals with the metals. In the first edition the metals were described in several separate parts, which are now included in the present stout volume of more than 1400 pages, forming the second volume of the new edition of the "Treatise." The characteristics of this treatise are well known to English chemists. It constitutes a half-way house between a complete *catalogue raisonné* of chemical facts and principles of which Gmelin's handbook is the last great example and the modern dictionary and treatise in which only important facts are recorded, and then in the briefest possible manner, historical allusions being either altogether omitted or reduced to their simplest terms.

The present volume presents an orderly and readable account of the metals and their compounds, due regard being paid to the history of their discovery. The volume opens with a general discussion of the metals, which might with advantage be expanded. Then follow clear accounts of the methods used in the determination of atomic and molecular weights, of valency, including a brief description of Werner's view of valency, of the classification of the elements, in connection with which it may be noticed that the system of classification adopted in the volume is that of groups of natural families, which is undoubtedly still the most convenient for the purposes of description—and description is the key-note of the present treatise. Atomic weights are given both in relation to hydrogen and to oxygen as unity. The physical properties of metals and the constitution of salts follow next, and here it is interesting to notice that electrolytic dissociation is accepted without comment, although little use is made of the hypothesis throughout the book, and the older type of chemical equation is preserved. No fewer than thirty-four pages are devoted to spectrum analysis, a section which might well be considerably condensed. More than forty pages are given to crystallography, another special subject of great importance. In view of the unwieldy size of the present volume, it is a question whether both these special subjects should not receive less detailed treatment in a treatise on the metals. The remainder of the volume relates to the description of the metals and their compounds, to which 1177 pages are devoted.

It must be confessed that, without changing the readable type in which the book is printed, and without omitting the historical notices and descriptions of metallurgical and manufacturing processes which form the most valuable feature of the "Treatise," there is room for very considerable condensation both in form and substance. Critical revision, both from a literary and a chemical standpoint, would lead to many changes for the better, and a reduction of the volume to nearly half its present dimensions without at all impairing its value. Nearly five pages are devoted to gunpowder of the old type, with voluminous tables relating to explosive processes and products, taken from the work of Noble and Abel of thirty-five years ago. Several pages are given to a description of processes of preparing alum which have long since been abandoned, yet in this account there is no allusion to the industry which once flourished on the Yorkshire coast, although alum manufacture in Italy and Asia Minor is mentioned. It would be easy to multiply instances of this kind and to point out many cases in which the exercise of a more critical judgment would have been beneficial, not only in eliminating unessential or unimportant material, but also in restricting a too luxurious licence in the use of words.

The historical information included in the volume is generally of great interest to the chemist as well as to the less technical reader, but here again much is recorded which is of doubtful value. The derivation of magnetite from Magnesia, a town in Lydia now known as Manisa, is at least plausible, but to urge in its support that Plato and Theophrastus called the mineral the "Heraclean stone," Heraclea being another name for Magnesia, is not likely to commend itself to anyone with knowledge of the subject. Magnetite is common throughout this country. Heraclea was probably a different town from Magnesia, and magnetite was probably found near both. One turns with interest to magnesium and manganese for information as to the origin of these words and their connection with magnetite, but the subject is left in confusion. It is a curious coincidence, if nothing more, and one of interest to the philologist, that the soil in the neighbourhood of Magnesia is particularly rich in the earth of that name.

The statement that "an alcoholic solution of ferric chloride was formerly employed as a quack medicine of repute, known by the name of Lamotte's golden drops," might well have been supplemented by the information that this solution is included in the British Pharmacopœia, and is still well known as "tincture of steel."

By far the most valuable sections of the book for the chemist will be the descriptions of modern metallurgical and manufacturing processes, which have been brought well up to date. More attention might have been given to the revision of the paragraphs relating to the occurrence of metals. The new source of tin in the highlands of West Africa, from which an appreciable output of the metal is already being obtained and which promises to have a great future, is not alluded to; whilst the occurrence of tungsten as wolframite with the tin ore of the Malay States is not mentioned under tungsten, although the separation of tungsten from tin is alluded to in connection with the metallurgy of tin.

The metallurgy of iron and steel is well described, but the discussions of the constitution of steel and of the rusting of iron leave much to be desired.

With all its imperfections, the "Treatise" is of great interest and value. As has been said, its strength lies in its descriptions of facts, which are usually accurate and clear. Criticism and generalisation are both weak points in the work. The chemist will, however, be thankful for a generally readable account of the subject, and even grateful to the author, who has not been deterred from his task by the appalling number and complexity of the facts of chemistry, a circumstance which is chiefly responsible for the calamity that the most notable treatise on chemistry written in English in recent times, notable alike for its grasp of detail, its power of generalisation, and not least for its extraordinary clearness in brief description, never got beyond that first volume, which astonished the chemical world nearly half a century ago.

## PRACTICAL PHYSICS.

*Practical Physics: a Laboratory Manual for Colleges and Technical Schools.* By W. S. Franklin, C. M. Crawford, and Barry MacNutt. Vol. i., Precise Measurements. Measurements in Mechanics and Heat. Pp. vii+173. Price 5s. net. Vol. ii., Elementary and Advanced Measurements in Electricity and Magnetism. Pp. vii+160. Price 5s. net. Vol. iii., Photometry. Experiments in Light and Sound. Pp. vii+80. Price 4s. net. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1908.)

THIRTY years ago Prof. E. C. Pickering published his "Physical Manipulation." The whole aim of the book, he told his readers, was to show how work in the physical laboratory might be made to teach a student to think for himself and to investigate; and in order to aid the instructor in the cultivation of originality he added to the 200 experiments described a hundred experimental problems as suggestions of what the student might with advantage be set to do.

In the book before us Pickering's aim has been completely lost sight of. The authors regard a laboratory course for undergraduates as

"having a two-fold purpose. On the one hand it serves to illustrate the principles of physics and their application to actual problems. . . . On the other hand it is intended to cultivate the power of accurate observation, to familiarise the student with methods of measurement, to give him skill and facility in the use of measuring instruments, and to develop in him the judgment necessary for the making of measurements in a manner adequate to the requirements of science, engineering and commercial work."

The character of the book is in close accord with the authors' conception of the educational utility of a laboratory course.

(1) The discussions by which most of the experimental exercises are introduced, while sufficient possibly for the objects in view, are in general quite insufficient to give the student an intelligent command of the methods involved. He is accordingly assumed not to have acquired it. There is some discussion, *e.g.*, of the balance and the barometer, and of the corrections which observations made with them may require, but the student is not trusted, in exercises in which these instruments are used, to settle the question of corrections for himself. He is told whether or not he is to apply any, and if any, which.

(2) The student is encouraged to make unintelligent use of formulæ. For example, he is given the expressions for the probable errors of an average and of a single observation, with a statement of their significance so short as to have a probable error of its own, and he is then directed in exercise after exercise to compute their values. He is not expected, apparently, to make any use of the results of his computations.

(3) Correct procedure being essential to the acquisition of skill in measuring, the student gets full directions as to what he is to do. Thus in the case of the Kelvin double bridge there is no general discussion of the arrangement, but a cut of a particular form of the bridge is given, and the student is even told to which binding-posts he must connect the terminals of his resistances and his galvanometer. The directions are not so detailed as this in all cases; but the course to be taken is in general fully pointed out.

(4) The student is in no case set to the serious investigation, or even testing, of physical laws. Perhaps the nearest approach to work of this kind is the study of the compressibility of air, and the following is a slightly condensed extract from the directions to the student:—

"Tabulate the values of $v(b \pm h)$ along with the values of $v$ and $(b \pm h)$,—the positive or negative sign to be used according as the pressure of the entrapped air is greater or less than the pressure of the outside air. Determine the mean of the tabulated values of $v(b \pm h)$, and tabulate the differences between this mean and each of the tabulated values of $v(b \pm h)$. These differences represent errors of observations. Plot the pairs of values of $v$ and $b \pm h$, using values of $v$ as abscissas and values of $b \pm h$ as ordinates, and draw a smooth curve among the points so plotted."

There is little scope for the student's initiative here.

As to extent, the book contains 132 selected experiments. It does not claim to be exhaustive. In the selection the needs of the technical student have been kept in view, and the advanced electricity and the photometry are especially technical in their character. Among somewhat unusual things which are included are the Venturi water-meter, flash-point determinations, decomposition voltages, mean horizontal candle-power, and integrating photometry. Among important things omitted are thermoelectric and resistance thermometry, ice and steam calorimetry, quadrant electrometers, differential galvanometers, Newton's rings, and cardinal points of lens systems.

The book has minor defects due to insufficient editing of the laboratory direction papers on which it appears to have been based. There are dreary repetitions of similar, sometimes identical, directions. Unusual terms such as abampere are employed without definition. There are references to "the instructor" which should have been replaced by references to published works:—"If the interferometer is not in adjustment, see instructor," for example. On the other hand, there are few slips, though Joule's experiment is credited to Thomson and Joule, and few typographical errors, though proper names are badly mangled.

The great defect of the book as a book for students is due to the fact that its aim is low. As hard thinking and independent thinking are essential features of any college discipline worthy of the name, a book the chief aim of which is to enable students to acquire skill in making measurements, though it may be useful for certain classes of technical students, could not be made a good book either for students generally or for the higher grades of technical students.

The chief merit of the book is the excellence of the advice it embodies as to the details of laboratory practice. From the authors' point of view procedure is of prime importance; and as a reference book on points of procedure their manual will be found useful even in old-fashioned laboratories which still aim at Pickering's ideal.

## A STUDY OF THE MOON.

*La Terre et la Lune: Forme extérieure et Structure interne.* By P. Puiseux. Pp. 176. (Paris: Gauthier-Villars, 1908.) Price 9 francs.

A BOOK which seeks to throw light on terrestrial evolution from a study of the moon must possess considerable interest to both geologists and astronomers. But we may prophesy that this book will be more welcomed by geologists than by astronomers, or, at any rate, by mathematicians. For M. Puiseux, disregarding somewhat lightly the weighty dynamical reasons which have been brought forward by Kelvin and Sir George Darwin, among others, in favour of a solid interior to the earth, throws in his lot with those geologists who support the theory of a thin crust surrounding a liquid interior. He bases his argument partly upon purely terrestrial phenomena—and here we must frankly admit that we do not find his reasons convincing—and partly upon analogy from the moon. M. Puiseux points out many interesting points of resemblance between the general configuration of the earth and some of the principal features of the moon's surface; and his argument that the moon's surface, having suffered but slightly from the action of water, can throw light on a stage of development through which the earth has passed has much to recommend it. But we fail to follow him in the further arguments that he brings forward to prove that it is only the reaction of a liquid interior on a gradually thickening crust which can have produced the effects which are now to be seen on the moon's surface.

M. Puiseux is on less controversial ground when he discusses the order of development of the various types of marking on the lunar surface. The careful study which he has made of the face of the moon compels special attention to be paid to his views on this subject, and many of his conclusions command the reader's assent. The probable origin of the lunar craters is particularly well discussed, a strong presentation of the case for volcanic origin being given. In this connection we cannot forbear to quote the delightful sentence with which M. Puiseux closes his discussion of the question. Speaking of two humps, survivors of what in his view was the primitive form of the crater, he says:—

"Il semble que l'on doive regarder ces rares témoins d'image disparu avec un peu de cette vénération que les archéologues ressentent en face des médailles antiques."

The discussion of the past history of the moon's surface and of the relations between the different types of markings is illustrated by a fine selection of enlargements of the Paris photographs of the moon; these help materially to emphasise M. Puiseux's contention that the photographic method is markedly superior to the older methods of studying the moon's surface. Perhaps we may suggest that it would render the photographs more useful to the general reader if the special features of interest which they present, and to which attention is directed in the text, were more clearly marked.

Each of the subjects dealt with in the book contains an interesting historical account of the theories and speculations that have from time to time been put forward. The older speculations are fully discussed, but there are several notable omissions of recent work. For instance, the discussions on the pear-shaped earth by Profs. Jeans and Sollas surely deserve consideration quite as much as Lowthian Green's tetrahedron. Again, Prof. Love's spherical harmonic analysis of the earth's surface should also be considered in any complete account of speculations on the figure of the earth, while some reference surely ought to have been made in the book to the planetesimal hypothesis of Profs. Moulton and Chamberlin.

There are one or two further omissions that must be noted. For instance, there is no reference to the need for revision of the present method of naming objects on the moon's surface, such as one not unnaturally looked for from a member of the international committee engaged in considering such a revision. Again, the earlier illustrations of the book would be brought into closer contact with the text if a more detailed account of modern geodetical methods were added. This could be done without overweighting the book.

There remains the never grateful task of pointing out some errors that have slipped into the work. Thus the statement on p. 88 that the physical libration and the elongation of the moon along the axis pointing to the earth have never been determined by observation is inaccurate; it shows neglect of the results obtained by Dr. Hayn. A further statement on p. 91 about libration suggests that the author is confusing the forced physical libration with the free or unforced libration, which has not been surely determined. Again, on p. 100, Sir George Darwin's earlier estimate of the rate of rotation of the earth when the moon separated from it is given instead of his later estimate, 2h. 24m. But these errors can easily be remedied in the second edition, for which the interest of the subjects dealt with in the book must inevitably call.

F. Stratton.

## CANCER AND ITS TREATMENT.

(1) *The Conquest of Cancer: a Plan of Campaign.* By C. W. Saleeby. Pp. xxiv+397. (London: Chapman and Hall, Ltd., 1907.) Price 7s. 6d. net.

(2) *Cancer: Relief of Pain and Possible Cure.* By Skene Keith and George E. Keith. Pp. ix+155. (London: Adam and Charles Black, 1908.) Price 2s. 6d. net.

(1) IN the "Conquest of Cancer" Dr. Saleeby gives a full account of the trophoblastic theory of cancer, and of the evidence which led Dr. Beard to suggest the pancreatic enzymes as a rational treatment for the disease.

Briefly stated, Dr. Beard believes that as in the development of lower animals there is an alternation of an asexual and of a sexual generation, so in the higher animals there is an asexual larval stage upon which the embryo proper develops. The larval tissue or trophoblast is transitory, and its germ cells should entirely disappear; but the germ cells may wander widely, and the natural degeneration they should undergo may not ensue. If the latter event happen, the ultimate fate of the aberrant germ cells varies; they may lie quiescent throughout life, or for some reason they may start into active proliferation. Should the latter event occur a cancerous growth is the result.

Now the normal degeneration and disappearance of the trophoblastic tissue coincide, according to Dr. Beard, with the development of the activity of the pancreas, and are due, according to him, to the digestive action of the pancreatic enzymes. If the pancreatic enzymes thus cause the disappearance of the trophoblastic tissue of the embryo, it may be expected that the same injected into a person suffering from a cancerous growth will similarly cause the growth to degenerate. The pancreatic enzymes attack and digest trophoblastic tissue, whether of the embryo or of the cancer, but have no effect on the normal tissues. This in brief is the theory on which the pancreatic enzyme treatment is based.

In the second half of the volume practical details are considered—cancer and surgery, preparation of ferments and details of treatment, claims of the treatment, and results obtained. Dr. Saleeby, of course, is enthusiastic; other accounts by no means support his enthusiasm. Nevertheless, it is to be hoped that the method will have a thorough trial with approved preparations of the ferments.

In the final portion of the book the medical journals which have criticised the enzyme treatment come in for some hard sayings on the part of Dr. Saleeby. NATURE, too, does not escape. Dr. Saleeby says:—

"NATURE is not a medical journal, but the leading scientific journal in this country. It published (December 20, 1906) an adverse comment on my *Pall Mall Gazette* articles, and in its reply to the letter which its remarks drew from Dr. Beard stated that 'the pancreatic enzymes must be injected into the neighbourhood of the growth or used locally; how then could the secondary growths in internal organs be attacked! Until this can be done, no cure for cancer will have been obtained.' Dr. Beard's second letter, correcting this most important and inexcusable error, was not inserted, and the statement was allowed to stand."

The qualifying words "we believe" (which appear before "the pancreatic enzymes," &c., in the original) are omitted from this quotation, and "this inexcusable error" was *not* allowed to stand, but was corrected in NATURE of February 28, 1907, p. 424. If this be a sample of Dr. Saleeby's accuracy, a doubt must arise as to the exactness of some of his other quotations.

(2) In the introduction to the second book, "Cancer," the authors remark, "We gave trypsin a very extensive trial, but were completely disappointed in its use." The treatment advocated is the injection of a mixture of iodipin (an organic iodine combination), cacodylate of iron (an arsenic preparation), and cinnimate of sodium. The authors claim that this treatment markedly relieves the pain and other symptoms of cancer, and occasionally seems to cure.

R. T. H.

## OUR BOOK SHELF.

*Mosses and Liverworts: an Introduction to their Study, with Hints as to their Collection and Preservation.* By H. T. Russell. Pp. xiii+200. (London: Sampson Low, Marston and Co., Ltd., 1908.) Price 4s. 6d. net.

NOTWITHSTANDING the frequent use of the term "life-history," the book under consideration only deals with the morphological side of the subject, and will be of greater service to systematists than to biologists. In the majority of systematic works, only just those structural features are countenanced that enable a student to determine the name of a given plant, the result being that a person may become fairly safe on the matter of names, whilst remaining quite innocent as to the general morphological and physiological features of the group he is studying. The second type of book, dealing with morphology proper, cytology, physiology, &c., that is, the biological aspect of the plant, is usually carefully avoided by the systematist. The present book follows a mean of the two extremes, and contains much useful information that would enable the systematist better to appreciate the part played by mosses and liverworts in the scheme of nature, and the ways and means by which such part is played.

Commencing with habitats, a very interesting account is given of the broad effects produced in nature by these minute plants, and also of their likes and dislikes in connection with climate, geological formations, and the surrounding vegetation. Commencing with the germination of the spore, the general morphological features of the succeeding structures of the asexual and sexual stages of a moss are treated somewhat in detail. The various vegetative modes of reproduction are also explained with accuracy. In dealing with the biological aspect of the subject, the author is not so much at home. Touching on the subject of fertilisation, it is stated:—"As a matter of fact we know no more of this process of fertilisation, what it is and how it is effected, than we know what life itself is and how it originated." Notwithstanding the occurrence of a few such blemishes, the book, as already stated, should prove of value to those students of mosses and liverworts whose sole knowledge of the structure of these plants is obtained from systematic works.

Eleven plates of very good figures illustrate the majority of the structural features dealt with in the text.

*Methods of Surveying.* A Manual for Students, Estate Agents, and Planters. By N. F. Mackenzie. Pp. ix+143; illustrated. (London: Bradbury, Agnew and Co., Ltd., 1908.)

WRITTEN by a practical surveyor and teacher, this manual is just what is required by the beginner, be he student or practitioner, in surveying. It contains just what is necessary and little that is superfluous; each step is so clearly indicated, and the little practical hints given are so apt, that a novice could go straight on with his work with only the manual to guide him; but a knowledge of plane geometry, trigonometry, and drawing is assumed. The book is only intended for teaching the methods employed in making large scale plans of comparatively small areas, therefore the methods of the trigonometrical survey and geodetic work are not given. The author deals in turn with chain surveying, prismatic compass surveys, theodolite traverses, levelling, plane table operations, and the determination and plotting of contours. Interspersed are chapters describing the various instruments, each of which is carefully explained in detail with the help of numerous photographs and diagrams. Problems are set and solved, and practical methods of overcoming incidental difficulties in the field are dealt with. As an example of the thoroughness with which each essential point is treated, one might take p. 21, where all the conventional signs employed to denote various objects shown on the finished plan are not only explained, but are also reproduced, and this is but one example among the many that this excellent manual contains. For teachers who have the desire, and are in a position, to teach real, practical geography, the book is the best we have yet seen. W. E. R.

*A Guide to the Domesticated Animals (other than Horses) exhibited in the Central and North Halls of the British Museum (Natural History).* Pp. vi+54; illustrated by 24 figures. (London: Printed by Order of the Trustees of the British Museum, 1908.) Price 6*d*.

DR. R. BOWDLER SHARPE states in a preface that this very attractive guide has been written by Mr. R. Lydekker, F.R.S., which is guarantee enough of its accuracy and completeness. The interest of the collection here dealt with to breeders, fanciers, and the public generally is self-apparent. Accompanied by such a guide as this little book provides, any intelligent person will be able to understand the principles exemplified by the specimens described. The excellent plates will make the book useful also to students unable to visit the museum.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### The Isothermal Layer of the Atmosphere.

IN NATURE of March 12, p. 437, I made some remarks under the above heading on temperature observations in the upper atmosphere, and suggested that it was desirable to have simultaneous records from thermographs of the different types in use in this country and abroad. From "Heft 2, Jahrgang 1907, of the Beob . . . . mit . . . . Ballons . . . ." recently published under the editorship of Prof. H. Hergesell, I find that the desirability of such comparisons had already been recognised on the Continent. There are only two or three examples of such comparisons in the volume, but they illustrate in a remarkable fashion the uncertainties which I was led to anticipate from general considerations. The thermographs compared were of two types—A (that of Monsieur Teisserenc de Bort), B (that of Prof. Hergesell).

Taking first Strassburg, we have data for the ascents only, on February 7 and 8, 1907. On February 8 the differences between A and B varied from 0·0 C. to 2°·1 C. in a total range of 52° C. In this case A gave, with one exception, the higher temperature, so the difference may have been partly due to "zero error" in one or both of the instruments. On February 7, as the balloon rose, the temperature recorded by A fell from −3°·4 C. at 140 metres to −60°·2 at 9280 metres. B, originally in agreement with A, gradually began to read lower, the difference amounting to 1°·8 when A recorded −34°·2. The difference then diminished, being only 1° C. when A recorded −60°·2. There then followed a thin isothermal layer, followed, as usual, by an inversion of temperature (a phenomenon not uncommon at comparatively low levels), but while A's temperature rose from −60°·2 to −58°·3 (or 1°·9 C.), B's only rose from −61°·2 to −60°·7 (or 0°·5 C.). The instruments then differed by 2°·4 C., and shortly after, when the ascent stopped—the temperature then being −53°·1 C.—by 2°·5 C.

When A, with falling temperature at 9140 metres, showed −58°·8, B read only 1°·2 lower, but when, after the inversion of temperature, A showed −58°·3 at 9690 metres, B read 2°·4 lower. There is thus in this case something quite different from mere zero or scale error. The cause must have been in the type or construction, or in the exposure of the instruments.

A still more instructive case is presented by the results obtained at Uccle on February 7, 1907, with the same two types of instruments; in this instance the observations are recorded during both ascent and descent. During the ascent the differences between A and B varied only from −0°·6 to +1°·1 C. As temperature fell to −42°, B usually read lower by a few tenths of a degree; at greater heights B read higher by from 0°·2 to 1°·1. During the descent, however, a marked difference of a systematic kind appeared, B reading higher than A. The maximum difference 2°·9 C. appeared when A recorded −46°·5, in spite of the fact that when A recorded −46°·3 during the *ascent*, B differed by only 0°·2. As the descent continued, the difference between A and B diminished and changed sign, until when A showed −8°·9, B read 1°·6 lower. Between the heights of 6000 and 1150 metres, when the extreme differences between A and B occurred, we have a range of 37°·6 from A as against 33°·1 from B, a difference of 4°·5 C., or about 12 per cent. On this occasion there was a marked inversion of temperature near the highest level attained, but the conclusions one would draw as to the nature or even as to the existence of an isothermal layer of finite thickness would depend a good deal on whether one took the ascending or descending readings, and in the latter event on whether A or B was accepted as correct. Thus, while A during the descent gave the same reading (−62°·5) at 9000 as at 10,090 metres, B read higher by 2°·2 at the lower level. Both at Strassburg and Uccle the differences between A and B became accentuated when temperature inversion occurred. So decided was the instrumental influence that in the short abstract accompanying the Uccle figures the writer speaks of "isothermie au T. de B."

In making these and previous comments, my object is not to criticise directly or indirectly any particular type of instrument, or any one observer or class of observers, but solely to secure the adequate and timely recognition of an idea, that idea being that no reasonable precaution should be omitted to ascertain how different types of meteorographs stand to one another, and how their records may best be interpreted. C. CHREE.

July 18, 1908.

### The Nature of the γ and X-Rays.

THE arguments contained in Dr. Barkla's letter to NATURE of May 7 do not directly affect the position which I have taken in respect to the nature of the γ and X-rays. I have shown that all the striking phenomena of the secondary kathode radiations are simply and completely explained on a neutral pair theory, but not on the older theory of ether pulses. Dr. Barkla refuses to consider this large body of evidence on the ground that it is well to deal with the simple and then proceed to the complex, and he would consider only the secondary X-rays. I grant this principle, of course, but I object entirely to the application which he makes of it. It is the γ rays which give the simpler effects, and the hardest γ rays which give the simplest, for the obvious reason that such rays ignore atomic structure altogether even in the case of the heaviest atoms. The X-rays are soft, and therefore atomic structure influences and complicates the effects to a remarkable degree, as Dr. Barkla's own work shows. A true application of the principle would lead us to work out the laws of the hard γ rays first, and then to consider the X-rays in the light of the knowledge we have obtained. This is what I have tried to do. The γ rays suggest a corpuscular hypothesis, and on turning to the X-rays it is at once clear that a large proportion of the effects which they show may also be simply explained on the same hypothesis.

Yet I am willing to meet Dr. Barkla even on the narrow ground on which alone he has chosen to risk encounter. He states certain pieces of evidence, numbered 1 to 9 in his letter, which should show convincingly that a theory of ether pulses is to be preferred to one of neutral pairs. Let us consider these.

No. 2 refers to the equal penetrating powers of primary and secondary rays in certain cases. This is a natural consequence of almost any theory, certainly of a corpuscular one, and the argument may be set aside at once.

No. 3 refers to the equality in the proportion of rays of different penetrating power which are scattered. The theory was given by Prof. Thomson in his "Conduction of Electricity through Gases," and experiments have been made by Dr. Barkla (*Phil. Mag.*, May, 1904) and Mr. Crowther (*Phil. Mag.*, November, 1907). The latter found notable exceptions to the rule, of which no theoretical explanation has yet been offered. The experiments are not easy, and there is enough chance of error to cover a considerable departure from the law, especially considering that no great variation of quality is possible with X-rays alone. In any case, there seems to be no reason for supposing the effect, if a true one, to be a special consequence of the pulse theory. It might well hold for a corpuscular theory, at least over the same limited range.

I have discussed No. 5 in a previous letter. The actual distribution of the secondary scattered rays agrees with the rule deduced by Dr. Barkla in special cases only. In others it does not, and the pulse theory does not say why. One might reasonably expect the rule to be of very partial application, for the secondary kathode radiation has such an extremely asymmetrical distribution that it is hard to believe in a complete symmetry of the remaining secondary radiation. Again, there seems to be nothing irreconcilable with a corpuscular theory.

As regards No. 6, it was asserted by Dr. Barkla as the result of his experiments that the ratio of the quantity of the secondary radiation to the quantity of the primary depended only on the density of the gas producing it. Prof. Thomson (*Phil. Mag.*, June, 1906) used the quantitative result as the base of one of three proofs that the number of electrons in an atom was nearly equal to the atomic weight. So far as I can judge, the proofs are not conclusive, and are not generally held to be so. In repeating Dr. Barkla's experiments, Mr. Crowther found the rule to be true only over a very limited range. C, N, and O did, indeed, give the same ratio, but all other atoms gave different ratios. In the case of H it was 70 per cent. larger, of He 10 per cent., of S 40 per cent., of Br about 8000 per cent., and so on. Any theory would show a constant effect over so narrow a range. Dr. Barkla considers his result to be evidence of value because it fits in with the result which Prof. Thomson derived from the ratio determined for air (N and O); but the strength of the other two proofs of Prof. Thomson's theory is hardly enough to permit this one to be removed and used to support Dr. Barkla's.

Nos. 1 and 4 refer to the well-known polarisation effects found by Dr. Barkla. The latter has been confirmed by Dr. Haga, who, however, rejects the former. I have already shown that it is not impossible to explain such effects on a neutral pair theory.

Lastly, there are the three statements Nos. 7, 8, and 9. They refer to certain remarkable effects observed by several workers, particularly M. Sagnac, Dr. Walter, Mr. Adams, and Dr. Barkla himself. Dr. Barkla says that they can be explained on the pulse theory. If any such explanation has been given I have not seen it, and I have not been able to devise any such explanation myself. The secondary X-rays from a substance like copper are homogeneous, and specially able to penetrate screens of the same substance. The homogeneity cannot result from sifting either primary or secondary rays, since it is complete when the radiation leaves the radiator, to say nothing of the difficulty of understanding how outer layers of a substance could sift rays emitted by inner layers of the same substance in the same condition. The effect cannot be due to anything like selective reflection, for then the secondary would be strongly turned back by screens of the same substance. For a similar reason it cannot be a true secondary. It must therefore be a transformed primary, transformed not by the conversion of primary energy into energy of secondary vibrations, but by a true change in its own properties. What can be suggested on the pulse theory as to the nature of this process? Again, in the case of the primary rays, a screen of any one substance has in nearly all cases the power of rendering the rays more penetrating to all other substances, but especially to that substance. It is true that this can be explained by sifting alone, *e.g.* a substance A might absorb soft rays, a substance B medium rays, and neither hard rays. But it can also be explained by true transformation of the primary as M. Sagnac and Dr. Walter have suggested, yet the transformation must not be accompanied by much scattering of the new radiation. I am aware that Mr. Adams (*Amer. Journ. Sci.*, xxiii., p. 376), unlike M. Sagnac, did not find any effect due to reversing two screens, but I am inclined to think that there is really some transformation of this sort. If that is so the effect will be very hard, if not impossible, to explain on the pulse theory. It is conceivable on a neutral pair theory, since the pair has properties which can be altered without disturbing the velocity and line of flight, so that the primary can be transformed without much scattering. Whether these surmises are correct or not, it seems to me that these particular phenomena give no support to the pulse theory.

Finally, it may be pointed out that the pulse theory will need radical alteration if it is to explain the asymmetrical effects which Dr. Madsen and I have lately investigated, and it is not clear that the revised theory will fit Dr. Barkla's experimental facts even as well as it does now.

W. H. Bragg.

The University of Adelaide, South Australia, June 25.

## The Discovery of the Weight of the Air.

The discovery, in the first half of the seventeenth century, that the air has weight is associated with things of immense importance, for instance, the invention of the barometer and the refutation of the dogma—dear to the false science and the false philosophy of the day—that "Nature abhors a vacuum." In a new edition of the "Essais de Jean Rey," reviewed in Nature of July 9, an attempt is made to assign this discovery to Rey, and, so far, to regard Torricelli, Galileo, Pascal, and Descartes as his disciples. Without claiming to be an authority upon Rey or upon Galileo, I would direct attention to the statement, made in "Galileo—his Life and Work," by J. J. Fahie, that Galileo's way of determining the specific gravity of the air was first described in his letter to Baliani dated March 12, 1613. Rey's "Essais" was published in the year 1630.

Erroneous suppositions regarding Rey being frequently made, I may be allowed to quote Humphry Davy's description of the "Essais" as "a mere logical exercise in physical science." The fact that metals on calcination increase in weight was known to Cardan, Scaliger, Fachsius, Cæsalpinus, Hamerus Poppius, and Libavius, who are mentioned by Rey. For confirmation of the fact he relied upon the statements of his friend "le sieur Brun," and altogether the evidence that Rey made experiments of any value in support of his doctrines is slight.

A. N. Meldrum.

Tannachie, Whitburn, Linlithgowshire, July 11.

## ASTRONOMICAL ARCHÆOLOGY IN WALES.

A SOCIETY for the astronomical study of ancient monuments in Wales is being formed in imitation of a society for the same purpose which has been for some time at work in Cornwall. The movement was inaugurated in August of last year at Swansea, where Sir Norman Lockyer delivered a lecture to the members of the Royal Institution of South Wales, the oldest scientific society in Wales, on the antiquity of the Gorsedd. At the close of the lecture a resolution was passed in favour of forming "a society for the astronomical study of stone monuments in Wales." Since then other local scientific societies have given formal pledges of support to the work, such as the Cardiff and Rhondda Naturalists' Societies, and the Astronomical Society of Wales. The Swansea Scientific Society, under the leadership of the experienced archæologist, Colonel W. Ll. Morgan, have surveyed several monuments with an accuracy sufficient to meet the requirements of the astronomical inquiry. A small society at Bridgend has started work in the same direction.

The Swansea men first showed their appreciation of the work by printing Sir Norman Lockyer's lecture, to which diagrams were added to make the pamphlet a handy field-book for workers.

In the spring Sir Norman visited Anglesey and Carnarvonshire, and the present writer joined him. Anglesey is regarded as the last home of Druidism in Wales, and we were very pleased to find the measures of the monuments there, so to speak, so uniformly orthodox. Both before and since the visit Lord Boston and Mr. Neil Baynes have also been working on the monuments.

The results of the measurements made are as follows. They have already been communicated to the fellows of the new society:—

*Theoretical Solar Azimuths, computed for sun's radius (2′ showing), taking refraction into account.*

| Alignment and conditions | Elevation of horizon 0° | 1° | 2° |
|---|---|---|---|
| Summer Solstice ... | N. 46 40 E. ... | N. 48 45 E. ... | N. 50 36 E. |
| Winter Solstice ... | S. 49 40 E. ... | S. 47 34 E. ... | S. 45 32 E. |
| May Sun ... ... | N. 60 48 E. ... | N. 62 32 E. ... | N. 64 12 E. |
| November Sun ... | S. 63 9 E. .. | S. 61 24 E. ... | S. 59 40 E. |

Latitude taken generally as 53° N., magnetic variation as 18° W.; in calculating the solar declinations it is assumed that 2′ of the sun's radius was showing, and refraction has been taken into account.

Measures made by Sir Norman Lockyer and Rev. J. Griffith.

*Summer Solstice, Rising (present declination, N. 23° 27′).*

*Bryn Celli Ddu.*
Magnetic, 69°; true, 51°; (value along creepway); hill estimated 2°.
Az., N. 51° E.; dec., 23° 31′ N.

*Summer Solstice, Setting.*

*Presaddfed.*
Magnetic, 152°; true, 134°; through cromlech to back stone. Amp. = E. 44° S. reversed; take 1° hill.
Az., N. 46° W., dec., 25° 2′ N.

*Winter Solstice, Rising.*

*Pen y Cnwc.*
Magnetic, 328°; reversed, 148°; true, 130°. Amp. E. 40° S.; sea horizon.
Az., S. 50° E., dec., 23° 28′ S.

*Glyn.*
Mag., 330°; reversed, 150°; true, 132°. Amp. E. 42° S.; take 1° hill.
Az., S. 48° E., dec., 23° 25′ S.

*Ty Newydd*, line of two supporters.
Mag., 155°; true, 137°. Amp., E. 47° S.; take 1° hill.
Az., S. 43° E., dec., 25° 47′ S.

*Cefn Isaf*, at right angles to big back stone (approximate).
Mag., 147°; true, 129°. Amp., E. 39° S.; hill, 0°.
Az., S. 51° E., dec., 22° 58′ S.

*Llanfechell.*
Line from cromlech to Meini Hirion (25-inch map); true, S. 50° E.; hill (from 1-inch map) about 26′; dec., 22° 35′ S.

*May Year (declination 16° 20′ N. or S.).*

*May.*

*Pant-y-Saer.*
Mag., 77°; true, 59°; sea horizon (visible).
Az., N. 59° E., dec., 17° 22′ N. May 10, August 4.

*November.*

*Plas Newydd.*
Mag., 137°; true, 119°. Amp., E. 29° S.; outlook toward Snowdon; hill, 3°.
Az. = S. 61° E., dec. = 14° 53′ S. November 2, February 9.

*Pleiades.*

*Plas Newydd Mound.*
Mag., 269°; reversed, 89°; true, 71°; hill, 0°.
Az. = N. 71° E., dec., 10° 50′ N. Pleiades, 1000 B.C.

*Ystum Cegid (Criccieth).*
Mag., 279°; reversed, 99°; true, 81°; hill, 4°.
Az. = N. 81° E., dec., 8° 30′ N. Pleiades, 1400 B.C.

*Clock Star.*

*Lligwy*, outstanding stone.
Mag., 208°; reversed, 28°; true, 10°; hill, ½°.
Az., N. 10° E., dec., 36° 15′. Capella, 1000 B.C.; Arcturus, 1200 B.C.

Measures by Lord Boston and E. N. Baynes, Esq.

*Summer Solstice, Rising.*

*Bryn Celli Ddu.*
Mag., 70°; true, 52°; hill (as above) estimated 2°.
Az., N. 52° E.; dec., 23° 0′ N.

*Ty Newydd.*
Mag., 71° 30′; true, 53° 30′; hill (as above), take 1°.
Az., N. 53° 30′ E.; dec., 21° 18′ N.

*November.*

*Bodowyr* (mean value of N. and S.E. stones).
Mag., 315°; reversed, 135°; true, 117°; hill (say), 2°.
Az., S. 63° E.; dec., 14° 50′ S. November 3, February 9.

*Equinoctial.*

*Lligwy*, angle of left opening stone; value from chamber under capstone.
Mag., 110°; true, 92°. Amp., E. 2° S.; sea horizon.
Az., S. 88° E.; dec., 1° 50′ S.

*Henblas*, direct outlook between supporters (approximate).
Mag., 108°; true, 90° = E.; hill (say), ½°; dec., 0°.

It is the aim of the society to bring together the workers on the astronomical inquiry. The annual subscription is three shillings. It is proposed to issue brief reports of progress. Besides the planning and orienting of the monuments, workers in Wales can help greatly by sending in all available information about them.

Now that the Prime Minister has promised to appoint a Royal Commission to inquire into the condition of the ancient monuments of Wales, it is to be hoped that advantage will be taken of such a golden opportunity to carry out an adequate astronomical survey of the stone monuments of the Principality.

JOHN GRIFFITH,
Hon. Sec., S.A.S.A.M. (Wales),
Llangynwyd, Glam.

## WILD-LIFE PHOTOGRAPHY IN AMERICA.

THE greater part of the June issue of the *National Geographic Magazine* is occupied by a lavishly illustrated article by the Hon. E. Shiras (who claims, we believe, to be the pioneer in flashlight photography) entitled "One Season's Game-bag with the Camera." The author is convinced that photographing big game in their native wilds is in a fair way to supersede shooting them, although we are fain to confess that so far as this country is concerned we fail to see marked, if any, signs of the supposed impending change. The suggestion of Mr. Shiras that "one can buy at half the cost [of shooting the animals] the skins or horns that later may adorn the home as a result of the hunting-trip" is most assuredly one that will not appeal to the present-day British sportsman.

Apart from all this, the author is to be heartily congratulated on the pictorial results of the three trips upon which the article before us is based. These three trips comprised one in April to an isolated coral-reef in the Bahama group tenanted by large breeding colonies of "man-of-war birds" and "boobies"; a second to New Brunswick in search of moose and deer, and later on to Newfoundland for caribou; and

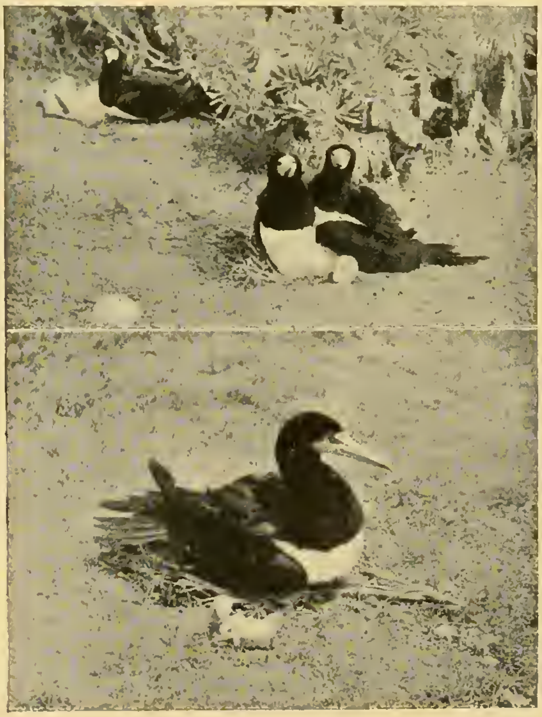


FIG. 1.—"Boobies" protecting their young from the sun, and a single bird incubating. From the *National Geographic Magazine*.

a third to Florida for brown pelicans and other local birds. The majority of the photographs were obtained on Kay Verde, as the aforesaid coral-reef is called, and comprise some excellent pictures of the booby colony, together with individual boobies incubating (herewith reproduced), and of man-of-war birds on the wing as well as of their callow young. It appears that the former birds are compelled to protect their

FIG. 2.—Caribou Stag with Symmetrical Horns. Photographed at a distance of 8 feet. From the *National Geographic Magazine*.

young from the fierce rays of the sun by brooding them with their wings. The photographs of flocks of pelicans on the wing come almost as a revelation, although in some instances the birds in the foreground are unavoidably more or less blurred. The picture of something like a thousand young pelicans disporting themselves at the water's edge is another calculated to make the bird-lover long for a glimpse of such a wondrous scene. Mr. Shiras was equally successful in "snap-shotting," either by flashlight or in daylight, moose in the forest and caribou swimming in the lakes, one of the pictures of the latter (Fig. 2) showing most admirably the white collar distinctive of full-grown stags.

## A CONTRIBUTION TO THE INDIGO QUESTION.[1]

A DECADE has elapsed since the chemical factories of Germany began to enter seriously into competition with plant indigo, and the gradual displacement of the latter by the synthetical product has from time to time been recorded in these columns. The writer of this notice was invited in 1900 to make known in this country the chemical history of this new development of applied science, and in a paper read before the Society of Arts the following year, after describing the various synthetical processes then available, attention was directed to the extraordinary want of skilled scientific supervision which had, down to that period, marked the cultivation of the plant and the processes of extraction carried on in India. In the year 1902 Mr. Bloxam was appointed to the research station of Dalsingh Serai, having associated with him Mr. H. M. Leake as biologist and Mr. R. S. Finlow as assistant chemist. Work was carried on in India by this staff until the spring of 1904, when Messrs. Bloxam and Leake returned to England.

[1] Report to the Government of India, containing an Account of the Research Work on Indigo performed in the University of Leeds, 1905–7. By W. Popplewell Bloxam, with the assistance of S. H. Wood, I. Q. Orchardson, R. Gaunt, and F. Thomas; and under the general supervision of Mr. A. G. Perkin, F.R.S., of the University of Leeds. (Published by Order of His Majesty's Secretary of State for India in Council.)

The results achieved down to that period were duly reported upon, and the report published by the Government of Bengal in 1905. Mr. Bloxam also gave an account of his work to the Chemical Society in 1904, and this was published by the Society in the 1905 volume of its Transactions. In the summer of 1905 the Government of India, through the India Office, authorised the continuation of the researches on indigo by Mr. Bloxam. The Clothworkers' Research Laboratory of the University of Leeds was appropriately chosen for the work, and the latter was placed under the general superintendence of Mr. A. G. Perkin, whose special familiarity with the chemistry of natural colouring matters is sufficiently well known to command full confidence in any results to which his name is attached.

So much by way of historical introduction. The report now before us is the outcome of the work carried on at Leeds by Mr. Bloxam and his colleagues from the summer of 1905 down to the end of last year. A careful consideration of the contents of this little official volume of about 117 pages will satisfy any impartial reader who is interested in the subject that the Indian Government has been well advised in the interests of a languishing native industry in authorising the continuation of the researches. The only point that arises, in fact, from the results so far obtained is whether the official authorisation of the work has not been prematurely brought to a close. The problems that have had to be worked out at Leeds are by no means simple—they were surrounded by experimental difficulties, and in spite of the very large amount of work carried out by the author and his colleagues, there still remain many questions of vital importance to the prospects of survival of natural indigo to which answers are urgently needed. To mention one only—why has it not hitherto been found possible to obtain from pure indican, the glucoside of indoxyl, a theoretical yield of indigotin by enzyme action or by chemical methods? It is probable that, under the conditions of manufacture, the indoxyl at the time of liberation, instead of condensing wholly to indigotin, gives rise to some secondary products (? indirubin and indigo brown) which, from a tinctorial point of view, represent so much loss of valuable material. If this secondary reaction could be converted into the indigotin condensation it might make an enormous difference in the struggle between natural and synthetic indigo. It is satisfactory to learn from the report that this point will be further investigated at Leeds.

The various papers published by Mr. Bloxam and his colleagues in the scientific and technical journals during the two years specified are re-printed in the present report, so that the case may be regarded as now presented in the order of its development. Section iii. is devoted to a consideration of the results of analysis of the indigo obtained from the "Mahai" of the plant grown on the experimental plots at the Dalsingh Serai Research Station during the season 1903. It is of interest to read, in connection with these results, the following passage:—"So to the author's extreme regret these expensive and laborious experiments result in inability to draw any exact conclusions as to the influence of the various manures —the results being completely obscured by the faulty and irregular nature of the 'Mahai'" (p. 98).

At the outset of his investigations the author decided, and we think wisely, that "before being certain of the efficiency of the manufacturing process, or of being able to suggest any valid improvement of it— two factors were necessary. (a) An accurate process for the estimation of the finished product (air-dried cake). (b) An accurate knowledge of the amount of colour which could be obtained theoretically from the manufacture, *i.e.* an accurate knowledge of the indigotin content of the green leaf." This extract furnishes the key to the whole of the subsequent work. It is now generally well known that a dependable analytical method for estimating indigotin has been worked out, and a very satisfactory process devised for estimating the indican in indigo-yielding plants. It is not necessary in these columns to enter into controversial points or into the minutiæ of analytical procedure. The merits of the "tetrasulphonate" method are sufficiently known to those who have used it or have seen it applied. Its accuracy is vouched for in an appendix to the present report by many well-known chemists who have given independent opinions—notably Prof. Norman Collie, Mr. A. C. Chapman, Prof. W. H. Perkin, and Prof. A. G. Green. As regards the beautiful application of v. Baeyer's synthesis of indirubin from isatin and indoxyl, suggested in the first place by Beijerinck as a suitable method for estimating indican, there was possibly a loophole for criticism in view of the most important fact that this method gives a higher result than any other known process for determining the quantity of indican in the leaf. It might have been fairly urged that in the leaf extract there might be contained substances other than indoxyl which, under the conditions of the analytical process, combine with isatin to give an insoluble compound which comes down with the indirubin and so adds to the weight of the dry precipitate. The answer to this objection is virtually contained in the present report, from which it appears that the indirubin obtained in the estimations is, as shown by ultimate analysis, a pure compound. But in order to get further assurance on this vital point, further experiments have, at the writer's request, been carried out at Leeds with the extract of the dried leaf of *Tephrosia purpurea*, in which not a trace of indican was found by the isatin method, the precipitate obtained being completely soluble in alkali. Special interest attaches to the selection of this plant because it is reputed to be indigo-yielding in a living state.

If it be now asked how, after this later work, stands the case for the indigo-planter, it must be conceded that if the results obtained by Mr. Bloxam and his colleagues are correct—and the present writer sees no reason for doubting their accuracy—there is yet hope for a considerable amelioration of the manufacturing process. The introduction of exact analytical methods has enabled the authors of this report to show that the older methods have overestimated the indigotin content of the dried "cake," and have underestimated the amount of indican in the leaf. If there is considerably more indican in the leaf than is accounted for by the present manufacturing process, there is assuredly scope for the further investigation of this process in the field. It may be a losing game; the "isatin method" may indicate results which are unrealisable in the factory. But these results are surely worth trying for in view of the enormous importance of the indigo cultivation to our Indian Empire. Even if the whole amount of indican in the plant cannot be made to yield the theoretical quantity of indigotin, there is still margin for such an improvement in the manufacture of plant indigo as to enable the latter at least to survive in face of the competition from the chemical manufacturers. Nor must it be forgotten that the Indian industry has a biological as well as a chemical side. The question was raised by the writer in 1901 whether there might not be plants suitable for cultivation in India containing a larger quantity of indican than those now made use of (*I. sumatrana* and *I. arrecta*). The answer is contained in the report before us:—"Attention is now called to the remarkable specimen of leaf (*I. sumatrana*) . . . yielding in the air-dried condition, on analysis by the isatin process, almost twice as much indigotin as the best specimen of Java leaf" (p. 109).

This particular specimen appears to have been grown in southern India.

It is, unfortunately, only too notorious that those whose interests have been most severely assailed by the synthetical product, viz. the planters themselves, have assumed an attitude of hostility towards these later attempts to place their industry on a scientific basis. They have been advised, as the result of independent investigations by their own experts, that their present method of manufacture leaves no room for improvement. If this be the real state of affairs, then it may safely be asserted that the days of the native industry are numbered. The case has been further complicated by a most regrettable antagonism of parties, and at one period assumed a polemical aspect most detrimental to the real cause at issue. That cause is, in brief, the survival or extinction of the Indian indigo planter. It has transpired in the course of the development of the case that the decision whether the planters have been doing themselves justice as manufacturers has been of necessity thrown back upon the accuracy of certain analytical methods. It is on this very point that there has, unhappily, been conflict of evidence, and the planters have chosen, perhaps not unnaturally, that verdict which appeared to mitigate their past neglect of the scientific side of their industry. But if they have been wrongly advised, their advisers have made themselves answerable to the Indian Government and to the Indian nation on the very serious charge of having deliberately brushed aside the one chance of re-establishing the native industry which might fairly be expected to follow from the practical development of the results now made known. There are many scientific chemists in this country who, with full knowledge of the facts of the case, are distinctly of opinion that even a partial realisation of these results would enable the natural colouring matter to compete successfully with its chemical rival.

R. MELDOLA.

## THE DUBLIN MEETING OF THE BRITISH ASSOCIATION.

ALL indications point to a successful meeting in Dublin this year for the British Association. The number of visitors already announced renders it very probable that the attendance will largely exceed that at the last Dublin meeting in 1878, and will compare favourably with many of the more recent meetings.

The list of papers to be read is practically complete, and the time allotted to scientific proceedings will be fully occupied, as will be seen from the provisional programmes of the sections given below. In Irish circles great interest is displayed in the discussion on the working of the Land Acts and the relation of railways to the State, problems on which the average Irishman is rather more of an expert than the ordinary citizen. That Sir Horace Plunkett will preside at the agricultural subsection, which deals with cooperation and allied matters, is a happy touch. Sir Horace founded, in 1896, the Recess Committee of Irish Parliamentarians, a non-political body convened for the purpose of gaining information with regard to the best methods of cooperative agriculture carried on abroad. That body subsequently led to the foundation of the Irish Board of Agriculture and Technical Instruction, which took over the whole of the work of the Science and Art Department in Ireland and a number of new duties, with the immediate result of regaining for the Irish producer much of his pre-eminence in the butter and egg market. Sir Horace Plunkett was the first vice-president of the new board, and although Ireland was considered to be "boarded over" already to suffocation, the new office had no difficulty in making itself beneficially felt from end to end of the country.

A considerable number of manufacturing establishments will be open to the inspection of members who visit Dublin. Foremost among these is Guinness's great brewery at St. James's Gate, one of the largest works of the kind in the world. These works will be open daily from 11 to 3, but the special British Association day will be Thursday, September 3.

The Dublin Corporation will show its electric light works daily from 10 to 4. These are situated on the site of the old Pigeon House Fort, on the south wall of Dublin Harbour. They lie right out in the sea, in the centre of Dublin Bay, surrounded by the unsurpassable scenery of the Dublin coast. The generating station of the Dublin United Tramway Company at Ringsend is also well worth a visit as the first representative of the three-phase system of traction in the United Kingdom. Dublin has every reason to be proud of its tramways.

Small parties of twelve will be admitted to Perry's planing and saw mills in Camden Row. I understand that ladies will not be encouraged to visit these, on account of the dangers threatened by the machinery.

No such restriction applies to Atkinson's poplin factory in Thomas Court, where visitors will be welcomed on the Tuesday, Wednesday, and Thursday. Poplin is a peculiar mixture of silk and linen, which combines most of the advantages of both materials. Its manufacture was introduced into Dublin by the Huguenot refugees in the eighteenth century, and has flourished ever since. Irish poplin is always among the materials worn at the Royal and Viceregal courts on Irish occasions.

Among the other establishments to be visited are Peterson's pipe factory, Jacob's biscuit works, Power's distillery, Winstanley's boot works, the Alliance gas works, and the great railway works of the Great Southern and Western Railway at Inchicore.

The social gatherings are numerous and attractive, as befits the gay city on the Liffey. On Wednesday, September 2 (the opening day), the Lord Mayor and Lady Mayoress will be at home at the pretty Mansion House in Dawson Street from 3 to 6 p.m.

On Thursday, September 3, the Provost and senior fellows will give a garden party at Trinity College from 3.30 to 6.30 p.m. This will be followed at 8 p.m. by a conversazione at Leinster House, the spacious and historic home of the Royal Dublin Society in Kildare Street. Smaller receptions will be given on Friday, September 4, by the Dean of St. Patrick's at his deanery, by the Irish Astronomer Royal at Dunsink Observatory, and by Miss White at Alexandra College. On the same day, at 2.30, a special *matinée* performance of Irish plays will be given at the Abbey Theatre (the Irish national theatre) of Yeats's *Hour Glass* and *Riders to the Sea*, and Lady Gregory's comedy *Spreading the News*. These should prove particularly enjoyable to those who look for a refreshing native atmosphere.

Saturday will be largely devoted to excursions, but a smaller conversazione will be given in the evening by the Classical Association of Ireland in the hall of the Royal College of Physicians.

For Sunday, September 6, special services will be arranged in various churches, and a special sacred concert, open to all members, will be given at the

Kingstown Pavilion, by special arrangement with Messrs. Adeler and Sutton.

The remaining days will be filled as follows:— Monday, September 7, 3.30 p.m., garden party at St. Anne's, Clontarf, given by Lord and Lady Ardilaun; Tuesday, 3.30, garden party at the Zoological Gardens, given by the local committee. At 8.30 p.m., reception by Viscount and Viscountess Iveagh at 80 St. Stephen's Green. Both Lord Iveagh and Lord Ardilaun belong to the Guinness family.

Wednesday, September 9 (closing day), garden party by their Excellencies the Lord Lieutenant and the Countess of Aberdeen at the Viceregal Lodge, Phœnix Park.

The excursion programme for Saturday, September 5, provides for six different routes. Perhaps the best of these is the excursion to Mellifont Abbey and the prehistoric tumuli of Dowth and Newgrange on the Boyne, passing on the way through Monasterboice and Drogheda. It leaves Amiens Street at 9.15 a.m., inclusive fare, 12*s.* Route B leads by Rathnew through the wild Devil's Glen to Glendalough, an old monastic retreat situated among the grandest scenery of County Wicklow. It leaves Harcourt Street 10 a.m., inclusive fare, 11*s.* 6*d.* Route C proceeds south-west to visit Killaloe, its cathedral, and (by steamer) Holy Island, on Lough Derg. It leaves Kingsbridge at 9 a.m., inclusive fare, 13*s.* 6*d.* Route D comprises Athlone, the "lordly Shannon," and the ancient and picturesque ecclesiastical ruins of Clonmacnois, where St. Kieran founded an abbey as early as A.D. 548. It leaves Broadstone station at 9 a.m., inclusive fare, 13*s.* 6*d.* Route E leads to Bray, the Dargle Glen, and to Powerscourt Waterfall, ending with a reception by the Earl and Countess of Meath at Kilruddery at 3.30 p.m. Route F leads south to the historic Rock of Cashel, Holycross Abbey, and Thurles. It leaves Kingsbridge at 9 a.m., inclusive fare, 13*s.*

Among the foreign invited guests of the British Association the following have accepted to date:— John Graham Brooks, Moritz J. Bonn (Munich), Prof. J. W. Brühl (Heidelberg), Prof. Ernst Francke (Berlin), Prof. Gustave Gilson (Louvain), Prof. A. A. Hubrecht (Utrecht), Prof. E. J. James (Illinois), C. W. Rubensen (Christiania), Prof. A. L. Rotch (of the Blue Hill Meteorological Observatory), Prof. Lotsy (Leyden), Haakon Schetelig (Bergen Museum), Prof. Achille Russo (Catania), M. Teisserenc de Bort (Paris), Prof. A. Kossel (Heidelberg), and W. Vernadsky (St. Petersburg).

A novel feature will be the intersectional telephone service, whereby a list of papers being read at each section will be on view at every section. This will be organised by means of a special telephone service worked by a staff of more than thirty operators. Communication between the various sections will be facilitated by a special tram service connecting all the sections, and also by a service of motor cars kindly placed at the disposal of the local committee.

The funds locally required have been subscribed without any very special effort, and a large amount of hospitality is being offered. E. E. FOURNIER.

## PROVISIONAL PROGRAMMES OF SECTIONS.

SECTION B (CHEMISTRY).—A leading feature in this year's programme are discussions arranged with the object of focussing as clearly as possible the present state of knowledge and opinion. The subjects selected are:—Fermentation; the nature of chemical change; peat; and colloids. In the first, Dr. Harden, Prof. A. J. Brown, Dr. Slator, Dr. E. F. Armstrong, and others are taking part. The subject of chemical change will be introduced by Prof. H. E. Armstrong, and his views should provoke a lively opposition on the part of the upholders of the ionic theory. Peat has been selected as likely to arouse local interest; those contributing include Dr. Wohltereck, Capt. Sankey, Prof. Ryan, Prof. Johnson, Prof. Lyon, Dr. Adeney, Mr. K. B. Eller, and others. Prof. Procter will present a report on the present position of the chemistry of the colloids, and Dr. Findlay promises a paper in this subject. Sir Wm. Ramsay, K.C.B., is contributing a popular account of his recent researches entitled "The Inactive Gases," in which these and the emanations will be dealt with in respect to the periodic table. Prof. W. H. Perkin will describe synthetical experiments in the terpene series, and other papers from his laboratory are promised by Messrs. C. Weizmann and R. Robinson. Further papers in organic chemistry will be contributed by Prof. F. S. Kipping—optically active silicon compounds—Dr. F. D. Chattaway, and Mr. M. Nierenstein. Prof. Pope and Mr. Barlow will deal with valency, a subject which provoked so much discussion last year. Other papers include:—The properties of oxygen; and the curriculum in chemistry, Prof. H. E. Armstrong; the selective permeability of the coverings of certain seeds, Prof. A. J. Brown; rapid electrolysis, Dr. Sand; mercerisation, Dr. Hübner.

SECTION C (GEOLOGY).—Great interest centres in the address of the president, Prof. J. Joly, F.R.S., who will deal with the question of radium and geology. At the Leicester meeting Prof. Joly gave a foretaste of the widespread effects which radium may exercise on geological problems, and in the hands of one who is at once a high authority on physics as well as geology we may look for important and stimulating results. After the president's address, Prof. Cole will give a popular lecture on the general geology of the Dublin district, and a series of excursions arranged by Mr. H. J. Seymour will enable members to gain a practical knowledge of the district. Other papers dealing with local geology will be given by Prof. Cole (1) on probable Cretaceous outliers off the coast of co. Kerry, (2) on the laterite and bauxite zone of north-east Ireland. Mr. H. Bolton will describe a section of the emerald pit at Dungannon, and an important contribution by Messrs. R. J. Ussher, H. J. Seymour, E. T. Newton, and Dr. R. F. Scharff will throw new light on the question of the age of some caves in Castle Park, near Doneraile. Petrology will be represented by papers by Dr. F. W. Hume on the petrography of Egypt, Prof. Joly will record the occurrence of native iron in the Deccan basalts, Mr. W. G. Fearnsides will describe the tourmaline rocks of Cwm Dwthwc, near Llanberis, and Mr. H. Brodrick will give an account of the formation of cave pearls. Palæontology does not promise to occupy an undue amount of time, but the announcement by Mr. H. Brodrick of the occurrence of reptilian footprints in the inferior oolite of Whitby, and the report on the fauna and flora of the Trias, will no doubt arouse some interest. In general geology, Prof. W. M. Davis, of Harvard, will give a new rendering of the glacial erosion which has taken place in the Snowdonian district. Dr. Tempest Anderson will describe the changes which have taken place in St. Vincent since the great eruption, and Dr. Woolacott will give an account of a case of thrust and crush brecciation in the magnesian limestone of co. Durham. A discussion on mountain building has been arranged, and it is expected that some of our foremost geologists will take part. *Habitués* of Section C always look forward to an address by Prof. J. Milne, and his contribution on the duration and direction of large earthquakes will be as suggestive and inspiring as any in the past. Besides the papers mentioned above, the results of the various research committees will be presented to the meeting.

SECTION D (ZOOLOGY).—Dr. S. F. Harmer, F.R.S., in his presidential address, will deal with polyzoa. *Discussions*:—(i) On the abuses resulting from the strict application of the rule of priority in zoological nomenclature, and on the means of protecting well-established names, opened by Mr. G. A. Boulenger, F.R.S.; probable speakers: the president, Dr. Smith Woodward, F.R.S., Dr. Hoyle (Manchester), and others. (ii) Determination of sex, opened by Mr. Doncaster; probable speakers: Prof. Bateson, F.R.S., Mr. Punnett, Mr. Walter Heape, F.R.S., Prof. Russo (University of Catania), jointly with Section K; afternoon lecture (lantern): Some points in the evolution of fishes, Dr. Smith Woodward, F.R.S. *Papers:* Wild ancestors of the domestic horse, Prof. Cossar Ewart, F.R.S.; gastrulation of Amphioxus, Prof. MacBride, F.R.S. (Montreal); Arctic and Antarctic Collembola, Prof. Carpenter; reciprocal mimicry or diaposematism, Dr. F. A. Dixey; migrations of wading birds, Prof. C. J. Patten; lantern demonstration of the segmentation of marsupial ova, Prof. J. P. Hill; an inquiry into the feeding habits of birds, Mr. Gordon Hewitt; some points connected with the vertebrate alimentary canal, Prof. Alex. Fraser; nerve cells and giant nerve fibres in worms, Dr. Ashworth; vascular system in Stylodrilus, Mr. R. Southern; (α) maxilla and palatine in mammalia, (β) epiphyses in reptilia, Prof. R. J. Anderson; distribution of Irish fresh-water mites, Mr. Halbert. Monday, September 7, will be devoted to a joint session with Section I.

SECTION E (GEOGRAPHY).—The president (Major E. H. Hills, C.M.G.), will give an address on the survey of the British Empire; Prof. W. M. Davis, of Harvard, will read a paper on the physiographic subdivisions of the Appalachian mountain system, and their effects upon settlement and history; the Rev. W. Spottswood Green will discuss certain effects of geographical conditions in Ireland; Prof. R. A. Gregory will discuss school geography as a mental discipline, and Prof. J. L. Myres will give a paper on the geographical study of Mediterranean man in connection with classical education; Mr. W. L. Grant, of Oxford University, will lecture on geographical conditions affecting the northward development of Canada, in especial view of the visit of the Association next year to Winnipeg; Capt. F. V. Thompson and Mr. E. A. Reeves will exhibit and demonstrate surveying instruments designed by them; Capt. Thompson's work has been directed towards the development of stereophotographic surveying; Mr. H. G. Fordham will discuss and illustrate early county maps of England and Wales; Capt. H. G. Lyons will lecture on the longitudinal section of the river Nile; Mr. L. G. Bernacchi will give some results of a visit to Peru, and the Rev. S. Furlong will describe and illustrate volcanic phenomena in Samoa; Mr. Harold Brodrick will give results of his explorations, with illustrations, in the Marble Arch caves in the county Fermanagh, and Dr. Charles A. Hill will similarly describe the Mitchelstown caves in the county Tipperary.

SUBSECTION F (AGRICULTURE).—*September* 3: Presidential address, Sir Horace Plunkett; agricultural education, Prof. J. R. Campbell; some Irish experiments on warble flies, Prof. G. H. Carpenter; Barley growing and selection in Ireland, Herbert Hunter; electricity in agriculture, Sir Oliver Lodge, F.R.S. *September* 4: Discussion on breeding and the relation of modern theories of heredity to the problems of the stock-raiser, opened by Prof. W. Bateson, F.R.S., followed by Prof. T. B. Wood, Mr. W. Heape, Mr. R. C. Punnett, Dr. J. F. A. Marshall, and Prof. James Wilson. *September* 7: Discussion on small holdings—some considerations on their successful establishment," opener, Mrs. Wilkins. *September* 8: Joint meeting with the economics section: psychological aspects of agrarian reform, Dr. Moritz J. Bonn; the increase in the productivity of English agriculturists during the last two centuries, Prof. James Wilson; statistical and economic investigation in agriculture, W. G. S. Adams.

SECTION G (ENGINEERING).—*September* 3: Address by the president of the section, Mr. Dugald Clerk, F.R.S. *September* 4: Report of the committee on gas explosions, to be followed by a discussion jointly with members of the physical and chemical sections. *September* 7: Recent advances in steam turbines, Mr. Gerald Stoney; producer gas, J. Emerson Dowson; suction gas producers, P. W. Robson; the utilisation of peat for making gas or charcoal, Capt. H. Riall Sankey, R.E. *September* 8: The laws of flight, F. W. Lanchester; on the causes of wear in motor vehicle machinery, F. H. Royce; on a fundamental error in the theory of power transmission by belts, W. Worby Beaumont; railless traction, F. Douglas Fox.

SECTION H (ANTHROPOLOGY).—The proceedings will include a number of communications of first importance. Prof. G. Elliot Smith will read a paper on the history of mummification in Egypt, and in a second communication —anthropological work in Egypt—will deal with the physical type of the Egyptians from the earliest discovered human remains to the present day. A paper by Mr. C. T. Currelly, on the sequence of Egyptian flint implements, is of special importance in reference to the question of the relation of the Stone age of Egypt to that of Asia and Europe. Mr. J. P. Droop will describe a Neolithic site in the valley of the Spercheos; Mr. Thompson, the important excavations in Sparta during the past season; while a communication by Prof. R. C. Bosanquet will deal with the Minoan settlements in eastern Crete. Local archæology finds a place in a discussion on the Iron age in Ireland, of which the nucleus will be formed by papers by Messrs. G. Cuffey, Armstrong, and Prof. Scharff, the last-named dealing with the early history of the horse in Ireland. Among other archæological papers may be mentioned one by Dr. H. Schetelig, of the Bergen Museum, on sculptured stones in Norway and their relation to some British monuments; prehistoric archæology in Japan, by Mr. Gordon Munro; and reports on the excavations made at Avebury by the Stone Circles Committee, at Caerwent by Dr. T. Ashby, and on the work of the Liverpool Committee for Excavation and Research in Wales and the Marches. Papers on general ethnography and the history of religion include a communication by Dr. C. G. Seligmann embodying the results of his recent expedition among the Veddahs of Ceylon; on a collection of Dinka laws and customs, by Mr. E. S. Hartland; the wandering of a cult in India—the god of the flood, by Sir Richard Temple; and a paper dealing with the origin and customs of the Mahrattas and Rajputs, by Mr. W. Crooke. Papers in physical anthropology include, in addition to that by Prof. Elliot Smith already mentioned, an important communication by Prof. D. J. Cunningham on the supraorbital region of the Neanderthal race; a paper by Mr. J. Gray, in which an attempt is made to identify the builders of the British Megalithic monuments with the hyperbrachycephalic race, of which remains have been discovered in the north-east of Scotland; and a paper by Prof. A. Fraser on certain points connected with the human brain.

SECTION I (PHYSIOLOGY).—*September* 3: Address of president, Dr. J. S. Haldane, F.R.S.; report of committee on the metabolic balance sheet of the individual tissues; report of committee on the effect of climate upon health and disease; report of committee on the ductless glands. *September* 4: Discussion on mental and muscular fatigue, opened by Dr. W. MacDougall, followed by Prof. J. S. MacDonald, Prof. T. H. Milroy (colour fatigue), Mr. H. Sackville Lawson (some aspects of mental fatigue, measurements by æsthesiometer); report of committee on body metabolism in cancer; report of committee on the electrical phenomena and metabolism of arum spadices. *September* 7: Joint meeting with Section D. Papers promised for joint meeting: Bionomics of tsetse-flies, R. Newstead; cultures of amœba, Dr. J. W. Stephens; on the action of atoxyl and allied compounds *in vivo* and *in vitro*, Dr. M. Nierenstein; on the life-history of piroplasma canis, Dr. A. Breinl and Mr. Hindle; pharmacological treatment of trypanosomiasis, Prof. B. Moore; the action of acids and alkalies on the growth and division of animal and vegetable cells, Prof. B. Moore and Dr. H. E. Roaf; digestive enzymes of invertebrates, Dr. H. E. Roaf. *September* 8: Discussion on instruction of school teachers in physiology and hygiene, opened by Prof. C. S. Sherrington, F.R.S., followed by Prof. W. H. Thompson and Prof. F. Gotch, F.R.S. Other papers (dates not yet arranged): Localisation of the brain in lemurs, Prof. W. H. Wilson and Prof. G. Elliot Smith, F.R.S.; localisation of the human cerebral cortex and the nature of sulci, Prof. G. Elliot Smith, F.R.S.; the functions of salts in metabolism—a request for information, Prof. H. E. Armstrong, F.R.S.; the relationship of the fundic to the pyloric part of the stomach, Dr. E. P. Cathcart. Arrangements will be made for demonstrations in the physiological laboratory of Trinity College.

SECTION K (BOTANY).—The presidential address will deal with the manifestations of the fundamental quantitative laws of physical chemistry in the living organism. Physiological communications are expected from Prof. Dixon, of Dublin, on the ascent of water in wood; from Prof. Bose, of Calcutta, on the mechanical and electrical responses of plants (with demonstrations); and from several workers in the Cambridge botany school on researches connected with photosynthesis in green plants; an account will be given by Miss Harriette Chick, of the Lister Institute, of the important laws governing the rate of killing of bacteria, brought out by the scientific study of disinfection; and some consideration will be given to the application of these laws to higher types of plants; Mr. Balls, of Cairo, will contribute a novel theory of the mechanism of mitosis; Mr. A. G. Tansley will read a paper on the woodlands of southern England, giving an account of the work done under the auspices of the central committee for the survey of British vegetation, by which a natural classification of these woods has been arrived at. There will be a discussion on the origin of dicotyledons, and the section will also join in a discussion organised by Section D on the determination of sex in animals and plants. It is expected that various distinguished foreign biologists, Prof. Bateson, and other zoologists will take part. Prof. Keeble, of Reading, will deliver the semi-popular lecture, giving an account of his interesting researches on the symbiosis between unicellular algæ and the marine worm Convoluta.

SECTION L (EDUCATIONAL SCIENCE).—Meetings for discussions and the reading of papers will be held in the mornings only. Visits have been arranged to selected schools on four afternoons. *September* 3: Presidential address, Prof. L. C. Miall, F.R.S.; the outlook: a grand experiment in education, Prof. H. E. Armstrong, F.R.S.; education under local authorities, Mr. R. Blair; schools for defective children, Mrs. Burgwin. *September* 4: Discussion on education in relation to rural life; openers, Prof. L. C. Miall, F.R.S., Prof. D. Houston, Miss Lilian J. Clarke, the Most Rev. Dr. Foley, Dr. W. J. M. Starkie, Mr. George Fletcher, and Mr. C. H. Bothamley. Practical studies in elementary schools: report of subcommittee on experimental science studies, Mr. W. M. Heller. *September* 7: Discussion on tests of educational efficiency (examination and inspection), openers, Mr. T. P. Gill and Dr. C. W. Kimmins; discussion on training in teaching, openers, Miss C. P. Tremain and Mr. C. Macgregor; open discussion on (1) note-taking and reports on work, (2) clear speaking and reading aloud, (3) motive and purpose in experimental work. *September* 8: Discussion on types of education and their relative values, openers, Dr. G. Archdall Reid and Prof. E. P. Culverwell; discussion on experimental inquiry in education, openers, Prof. J. J. Findlay (with Mr. P. Sandiford) and Prof. J. A. Green; curricula of secondary schools: report of subcommittee on the sequence of science subjects, Mr. G. F. Daniell.

## *LORD BLYTHSWOOD, F.R.S.*

THE number of great territorial magnates who take a practical interest in science is no doubt larger than appears at first sight, but it is nevertheless regrettably small. Many of our landed gentry are unfitted by inclination and temperament to play any part in the game of politics, and their education, though it has not been without a certain valuable influence on character, has not, as a rule, been such as to encourage and develop that healthy and keen interest in natural things which is shown by almost all boys at an early age. Thus too many men, who have been placed by fortune above the necessity of earning their living in business or in the professions, are driven to spend their days in sport of one kind or another from year's end to year's end. At the best they lead a life, healthy it may be in a physical sense, but productive of no particular good to the community or the world at large, and detrimental to the strong plea which can be put forward for the existence of a leisured and broadly cultured class.

Happily there are and have been notable exceptions, and among these the late Sir Archibald Campbell, Lord Blythswood, must be accorded a high place. Born in 1835, the son of Archibald Campbell of Blythswood, he was of direct descent from the old Douglases who played such a prominent part in the English and Scottish wars of the thirteenth and fourteenth centuries, and was a member of the semi-regal family of the Campbells, who, whatever faults and foibles may have been rightly or wrongly attributed to them, have been conspicuous in the Scottish struggle for civil and religious freedom. In early life he was, as befitted such an ancestry, both soldier and politician. He saw active service with the Scots Guards in the Crimea, where he was severely wounded, and continued in the army until the death of his father in 1868. He then retired with the rank of lieutenant-colonel, to devote himself during the remainder of his life to work for the auxiliary forces, to politics (he was a keen Conservative), and to science.

He was married in 1864 to the elder sister of the present Lord Carrington, and held the offices of Lord Lieutenant of the County of Renfrew and of *aide-de-camp* to the late Queen Victoria. He sat in Parliament for West Renfrewshire from 1885 until 1892, when he was raised to the peerage as Baron Blythswood. He was elected to the Fellowship of the Royal Society in 1907. For some time Lord Blythswood had been in failing health, and the early part of the present summer was spent by him and Lady Blythswood in the south of France. On July 8 he died of heart failure at his seat of Blythswood, near Renfrew.

For a long time Lord and Lady Blythswood acted as hosts to members of the Royal family when they visited the west of Scotland for public functions; he entertained the King and Queen when—as Prince and Princess of Wales—they visited Glasgow to lay the foundation stone of the new university buildings at Gilmorehill in 1870, Queen Victoria when she opened the Glasgow Exhibition in 1888, and the Prince and Princess of Wales when they opened the new Natural Philosophy Institute and the new medical buildings of the university in April of last year.

But though Lord Blythswood had many interests, and devoted much time and attention to them all, his ruling passion was for physical science. He established at Blythswood a laboratory and workshop, which he equipped with the best instruments which could be procured for investigation, and with tools of the most refined description for the construction of apparatus and for the realisation of his own ideas regarding astronomical and physical machinery.

He employed skilled experimenters and mechanics to aid him in the work of construction and observation, and he obtained some notable results. He was a strenuous worker with his own hands at the bench; indeed, one of the most striking exhibits of the Glasgow Exhibition of 1888 was some fine wheelwork (for a magnificent astronomical driving clock), which had been cut by him in an almost incredible number of hours of continuous work.

Lord Blythswood's earlier work was mainly constructional, and valuable service was rendered to science by the improvement of tools and processes which resulted. A very important instrument, his great dividing engine, is perhaps the most striking outcome of this part of his scientific activity. As it now stands, this instrument is capable of ruling diffraction gratings with very great accuracy to as many as 14,400 lines to the inch, and many gratings of excellent optical quality have been made with it; but it has taken twenty-five years of modification and improvement to bring it to its present state. By a carefully designed and ingenious motion the diamond point is brought very gradually into contact with the surface to be ruled, so that disaster from its breaking is entirely avoided. Surely the skill and patience required for such work is as well deserving of recognition as a service to science as many more showy performances.

Several very large Wimshurst electrical machines (including one of 160 plates!), in which the oppositely rotating plates are specially mounted so as to run truly and smoothly, were made in the workshop, and greatly increased the experimental resources available for X-ray work and the investigation of the phenomena of electrical discharge.

Lord Blythswood himself came very near to the discovery of the X-rays, for he had obtained photographic action through various opaque substances before Röntgen made his memorable announcement. Since that time much work has been done in the Blythswood laboratory on this subject. With the skilful help of Mr. H. S. Allen, and more lately of Mr. Walter Scoble, Lord Blythswood carried out many interesting researches on spectrum photography and the Zeeman effect, in radiography, and in radio-activity generally.

During the last year or so Lord Blythswood and Mr. Scoble had been engaged in experiments in flight. In the course of these they designed an air-engine for a model aëroplane, which gave more than one-half of a horse-power and weighed only two pounds! The air for driving this engine was stored in the liquid form, so as to keep down the weight of the containing vessel.

At the end of a long and active life, Lord Blythswood has passed away, leaving a fine record behind him of good work done and notable results obtained. If his example should lead other men of means and leisure to follow in the same path, then in a more than usual but very real and true sense his work will follow him.

A. Gray.

## THE NATURAL HISTORY MUSEUM.

TEN years ago, upon the retirement of Sir William Flower from the post of director of the Natural History Museum, a memorial signed by many distinguished men of science (see Nature, July 14, 1898) was presented to the trustees of the British Museum urging that it is "of great importance to the welfare of natural history that the principal official in charge of the national collections relating to this subject should not be subordinate in authority to any other officer of the Museum." The recent retirement of Sir Ray Lankester has again provided an opportunity for pressing the adoption of this principle, and a strong deputation waited upon the Prime Minister on Tuesday to ask for an inquiry into the administration of the Museum. From the *Times* report we extract the following account of the interview:—

Prof. Adam Sedgwick, F.R.S., said the objections to the present administration of the Natural History Museum had reference to a system, and not to individuals. For many years the condition of the Natural History Museum and its mode of government had been a standing grievance to naturalists, and many endeavours had been made to obtain a separate government for it. The reasons of the deputation for asking for an inquiry could not be better expressed than by summarising the history of the principal attempts which have been made to bring about a change in the methods of administration of the museum. Forty-two years ago the most distinguished men of science of the day, in a memorial to the Government, expressed the opinion that "it is of fundamental importance to the progress of the natural sciences in this country that the administration of the national natural history collections should be separated from that of the library and art collections." Thirty-five years ago a Royal Commission, in pressing the same points, directed attention to the statements of witnesses that it was "unsatisfactory that the national collection should be managed by a body of gentlemen whose time is in most cases fully occupied by other important duties, and the majority of whom are not selected with reference to any special qualifications for such a post." Twenty-nine years ago the council of the British Association for the Advancement of Science endorsed these recommendations both of the Royal Commission and of the leading naturalists of the day, and strongly urged upon the Government the importance of giving effect to them. Ten years ago a representative body of scientific men presented a memorial to the trustees, in which it was urged that the principal official in charge of the national collections relating to natural history should not be subordinate in authority to any other officer of the museum. The present deputation also felt that the method of administration of this great national institution, which had not only been an important means of scientific research and an example to other nations, but had given the highest instruction and purest delight to hundreds of thousands of persons was in matters of vital importance seriously defective. They were there to ask for a full official inquiry into the organisation and administration of the Natural History Museum, with the view of a reasonable treatment of the matter in the immediate future by the Government.

Speeches in support of the views above expressed were made also by Mr. Francis Darwin, F.R.S., Prof. G. C. Bourne, and others.

In reply, Mr. Asquith pointed out that, as regards the administration of the museum, the trustees are a superior body with whom the Government are powerless to interfere. The arguments advanced by the deputation as to the management by the trustees apply equally to the Bloomsbury Museum. The trustees, men of wide experience and great discretion, are equally cognisant of natural history and archæology. The trustees are about to appoint a keeper of zoology, and it is not intended to abolish the directorship, but only to wait to ascertain who is the best man for the responsible position. He sympathised with the view that the director should have a free hand in the management of his department, and promised to convey to his fellow-trustees of the British Museum all that the deputation suggested.

## NOTES.

We regret to see the announcement of the death, on July 27, of Sir Thomas Stevenson at seventy years of age. Sir Thomas was appointed senior scientific analyst to the Home Office in 1881, and was knighted in 1904. He was past-president of the Society of Medical Officers of Health, the Society of Public Analysts, and the Institute of Chemistry. He was also the author and editor of various memoirs on forensic medicine.

The death is announced, at sixty-seven years of age, of the engineer René Panhard, whose name is well known in connection with the development of the motor-car. We also notice the announcement of the death of Prof. Daguillon, assistant professor of botany at the Sorbonne, Paris, and author of a number of books upon botanical science.

The German Kepler Society has founded a prize of 50*l*. to encourage research on the early traces of life (pre-Silurian) and their relation to the theory of evolution.

At the congress of historical sciences to be held in Berlin on August 6–12, there will be a section concerned with the history of science. Among communications to be dealt with in this section are, we learn from the *Revue scientifique*, the work of Avogadro from the point of view of chemical theory, by Prof. Guareschi, of the University of Turin; the history of the development of physical chemistry, by Prof. Gerland, of Clausthal School of Mines; Arab contributions to the progress of science, by Prof. Wiederman; and on Boyle's law, by M. F. Mentré.

Among other prizes offered for scientific researches in Italy, we note a gold medal, of value 40*l*., offered for the best essay on "galvanism" (*i.e.* animal electricity) by the Bologna Academy, the last date of entry being May 26, 1909; and one of 20*l.* for the best work on the mineralogy of Vesuvius, offered by the Naples Academy, for which essays have to be sent in not later than June 30, 1909. In either case the essays may be in Latin, French, or Italian, and must be sent in under a *nom de plume*, the author's name being enclosed in a sealed envelope.

THE Italian Geographical Society (Rome, 102 Via del Plebiscito) offers a prize of 200*l.* for the best original work by an Italian author on economic geography, *i.e.* geography studied in its relations with commerce, emigration, and colonisation, with special reference to Italian economic requirements.

MR. W. T. LYNN has kindly sent us the following answer to the inquiry of a correspondent as to why June 24 is called Midsummer Day:—"Our ancestors decided that the quarter-days should be the sacred or holy days nearest to the four astronomical quarters, that is, the two solstices and the two equinoxes. So the four quarter-days are March 25 (Lady Day), June 24 (St. John the Baptist's Day), September 29 (St. Michael and All Angels' Day), and December 25 (Christmas Day). As the June quarter (St. John the Baptist's Day) was so near Midsummer, it acquired the name of Midsummer Day. If it be further asked why June 24 was St. John the Baptist's Day, it is that it means the day of his birth, and it would appear from Luke i. 26 that this was a little more than six months before that of Christ, so it is taken as six months and one day before Christmas day."

MR. C. KENRICK GIBBONS has presented to the Zoological Gardens a large number of the small fresh-water fish from Barbados known as "millions" (*Girardinus poecilloides*). These little fish, which have been placed in a tank in the tortoise house, are of special interest because of their supposed action in preventing malaria. Malaria is very much less common in Barbados than in other West Indian Islands, and it has been suggested that this freedom is due to the presence of enormous quantities of the "millions" in the fresh-water pools. The little fish are very voracious, and destroy large numbers of the larvæ of mosquitoes that spread malaria. The males are about half an inch long, with brilliant iridescent colours, and large black spots on the sides. The females are considerably larger and less highly coloured. It is understood that experiments are going to be made with the introduction of these fish into tropical countries where malaria is prevalent.

AT a meeting of the British Academy, held on July 22, Prof. R. S. Conway reported the results of his tour in Austria and the north of Italy, undertaken with the aid of the academy in order to collect inscriptional and other material for the study of the ethnological questions which he indicated at a meeting of the academy in May, 1907. From the report in the *Times*, we learn that Prof. Conway said he has revised and made many corrections in the text of nearly all the inscriptions previously known (about eighty-eight in number), leaving only six or seven which proved inaccessible within the limits of time at his disposal. Of the eighty-eight, three are Etruscan, and ten belong to a problematic group which it is convenient to call Rhætic, found mostly in the region of the Brenner Pass, both north and south of it. To this group are added eight hitherto unpublished; but nothing definite can at present be said as to their language or languages. On the ethnological questions, Prof. Conway reported that none of the Venetic inscriptions is older than 500 B.C., and that they were certainly written by a community which shared the Villanova culture, which first appeared in Este, as in Bologna, according to the accepted dating, in the eleventh or tenth century B.C. It remains, therefore, still to be determined whether, as Strabo thought, they were identical with the Veneti of Gaul, and so brought the language with them into Italy, or whether they merely learned the language from the people on the soil when they arrived.

ACCORDING to the report for 1907, the Rhodesian Museum at Bulawayo continues to make satisfactory progress, although its expansion is somewhat hindered by lack of sufficient funds. The curator contributes a list of the local mammals in the collection.

THE ticks (Ixodoidea) of the United States are reviewed and re-arranged by N. Banks in Bulletin No. 15 of the technical series published by the Entomological Bureau of the U.S. Department of Agriculture, a work which, according to the author, was urgently needed. Africa is the true home of ticks, all the genera being represented on that continent, where species are likewise most numerous.

SOME time ago the Field Columbian Museum received an application from the President of Guatemala for advice concerning the possibility of introducing food-fishes from the United States into lakes Amatitlan and Atitlan. Mr. S. E. Meek was accordingly dispatched to Guatemala, and his report is now published by the museum as No. 6 of vol. vii. of the zoological series. It deals with the general zoology of the lakes, although devoting special attention to the fishes, and as our information with regard to the natural history of tropical lakes is very meagre, its interest is considerable.

ACCORDING to the report for 1907, the working of the Field Columbian Museum at Chicago has been rendered simpler and easier by the introduction of new regulations, which have now been in force for a twelvemonth. An important event of the year was the receipt of a sum of money to defray the expenses of an expedition about to be dispatched, where it is to remain for a period of three years. The report also includes an account of the results of a collecting expedition sent by the museum to British East Africa, the account being illustrated by photographs of a recently killed rhinoceros and giraffe. The latter evidently belongs to the race known as *Giraffa camelopardalis tippelskirchi*, athough this is not mentioned on the plate.

THE mode of origin of new colonies of the South American sauba-ant (*Atta sexdens*) forms the subject of an article by Dr. J. Huber in vol. v., No. 1, of the *Boletim do Museu Goeldi* at Pará. As the result of recent observations, the statements of the older naturalists to the effect that a single fertilised female is capable of founding a colony by herself are proved to be true. The first batch of workers in the new colony appears to be developed within a minimum period of forty days. When these workers (the mode of alimentation of which is referred to in the paper) are fully developed, they forthwith commence the cultivation of the Rozites mycelium on leaves, the larvæ of the later broods being nourished on the "kohlrabi," or growths produced in the leaves by the presence of the fungus.

To the July number of the *Century Magazine* Mr. C. R. Stockyard contributes an interesting account of the fishery for spoon-beaked sturgeon (*Polyodon spatula*) in the lakes of the Mississippi region, together with notes on the habits of these huge fishes. The fishery is principally carried on for the sake of the caviar yielded by these sturgeons, although the flesh, which is smoked and dried, also forms an important asset. These sturgeons attain a maximum weight of about 140 lb., with a length of nearly 6 feet, and in the case of a female yield some 16 lb. of roe. The average is, however, considerably below this, the yield of caviar being about 10 lb. Caviar is obtained from the roe by washing the eggs out of the membrane in which they are enveloped. The energy with which the fishery is carried on has greatly reduced the number of sturgeons in the lakes, where they do not breed, and plans for increasing the stock are under consideration. One of these fishes leaping out of the water in their characteristic fashion forms the subject of a full-page illustration.

In the June number of the *Quarterly Journal of Microscopical Science*, Sir E. Ray Lankester states that a minute chlorophyllogenous organism, described by himself in 1885 as *Archerina boltoni*, is identical with the subsequently named *Golenkinia radiata*, and also with *Richteriella botryoides*, and he accordingly urges that the two last-mentioned names should give way to the one proposed by himself. Owing, apparently, to its frequent association with extraneous amœboid protoplasm, Archerina was referred by its describer to the Protozoa, whereas it now turns out to be a plant. Since names employed in zoology are not considered to preoccupy those used in botany (and *vice versâ*), it remains to be seen whether the proposed change in nomenclature will be accepted by the botanists. In the same issue Prof. E. A. Minchin continues his account of the ascon-sponges, dealing in this instance specially with the mode of spicule-formation in the genus Leucosolenia, while Mr. C. L. Boulenger describes a new genus of hydromedusans from Lake Qurun, in the Fayum province of Egypt.

A short paper on the development of flowers as influenced by the partial removal of roots and leaves is communicated by Mr. M. Shiga to the Journal of the College of Science, Tokio (vol. xxiii., article 4). The result of the few experiments recorded tends to show that moderate root-pruning hastens flowering, but leaf-removal is deleterious.

Mr. H. Pittier supplies a note on the Lecythidaceæ of Costa Rica to the series of Contributions from the United States National Herbarium (vol. xii., No. 2), in which two new species of Eschweilera and one of Lecythis are described and illustrated. These genera belong to the group that bear the characteristic "pyxidium" fruit. The seeds of the Lecythis are stated to have a finer flavour than the Brazil nut. The number also contains the diagnosis of a new apocynaceous genus, Tonduzia, by Mr. Pittier, and the identifications of a collection of Venezuelan plants by Mr. J. R. Johnston.

A picturesque narrative of the expedition undertaken by New Zealand men of science to the southern islands attached to the dominion occupies the first place in the latest instalment (No. 6) of the *Kew Bulletin*. Captain Dorrien Smith furnishes the biological account of the Auckland Isles. The striking vegetative features consist of a Rata, *Metrosideros lucida*, formation at the lower level; higher up, *Danthonia bromoides* forms large tussocks growing out of its own peat, and *Suttonia divaricatum* develops into a close scrub about waist high which can be traversed above, or under which the traveller may crawl. The occurrence of a tree fern, *Hemitelia Smithii*, in this southerly latitude testifies to the remarkable climate. Dr. Cockayne's account of the Snares Islands is also reproduced.

From the article communicated to the *Kew Bulletin* (No. 6) by Dr. O. Stapf, there is reason to expect that a rubber-yielding tree of Indo-China, *Bleekrodea tonkinensis*, which has been made the subject of special investigation and report, may prove to be more valuable than the various other recent discoveries in this direction. The tree was found in the forests of Tonkin, where, on a dry soil, it forms gregarious areas. It produces a latex fairly rich in caoutchouc that is best separated by treatment with sulphuric acid. The rubber, known in the vernacular as "teo-non," has been compared with Para. In connection with the rubber industry, the Bulletin contains a copy of a despatch from Mexico announcing that the supply of the plant yielding "Guayule" rubber is coming to an end, as reproduction is for practical purposes impossible owing to its slow growth.

The first number of vol. vii. of *Abhandlungen der k.k. Geographischen Gesellschaft in Wien* contains a paper by Dr. Th. A. Ippen on the mountains of north-west Albania. After giving a general description of the mountain ranges, Dr. Ippen discusses in detail the valleys on the south side of the North Albanian Alps, commenting on the population and the means of communication in the Drin or Dukadschin mountains. Geographical details are given of the Fandi valleys and the Mirdita district, and the relation between the physical features and the industries of the inhabitants noticed. In a section dealing with the valley of the Mat, Dr. Ippen describes the Matja, Birschkasch, Uraka, and Kurbin districts, and discusses the customs and history of the inhabitants from evidence collected in the ruins of ancient villages. Further observations are still needed in the valleys of the Valbrona, Zmya, and Uraka, and in the district between Prizren and Djakova.

The recent claim that the geysers in the Yellowstone Park are exhibiting signs of diminishing energy is discussed by Dr. Roland Dwight Grant in the Bulletin of the American Geographical Society for May. Changes observed in the colouring of the Minerva and Angel Terraces indicate that apparent diminutions of energy are due in reality to the diversion of the hot-water current to a new direction. The Excelsior Geyser is mentioned as an illustration of the many apparently dead geysers which have ceased to play on account of less clearly defined throats. Dr. Grant describes the Fountain and Black Growler geysers, which ceased to play owing to breaks in their pipes. He emphasises the fact, however, that in both cases the energy had merely been diverted to form new geysers, and that the current tended to return when the disturbing force ceased to act. The "mud volcano" is described, and the regularity of its action noticed. As a result of his observations in the Yellowstone Park, therefore, Dr. Grant is of opinion that the supposition of diminishing energy is unfounded.

We have received the results of the magnetical and meteorological observations made at the Royal Alfred Observatory, Mauritius, in the year 1906. Having already referred to the report of the observatory for that year, we need only add that the results obtained from the self-registering instruments, the records of which are tabulated for each hour, and from eye observations, are very carefully worked out on the pattern of the Greenwich observations; monthly and annual rainfall at sixty-five stations are also given. The mean rainfall for the year over the whole island was 73·44 inches, as compared with the average 80·34 inches. Particulars are given of sixty-four earth movements shown by the photographic records of a Milne's seismograph during 1906.

The report of the meteorological observations made at the Perth Observatory and other places in Western Australia in 1906 contains much useful information. The tables for Perth, which are given in great detail, include monthly mean values of the principal elements from 1876; monthly and yearly results are also given for some fifty stations, and rainfall at a large number of places, with averages for previous years. Mr. Cooke, the Government astronomer, remarks that the readings from the various localities may be considered trustworthy; some very high shade temperatures are recorded, *e.g.* 116°·4 at Eyre (January 22), and maxima exceeding 100° were recorded at the majority of stations. In previous years readings of 117° were observed at several places. The weather forecasts are very accurate; figures 1–5 are added to each forecast to indicate its degree of probability. Eliminating those stated at the time to be very doubtful, the success was 96 per cent.

In the *Bulletin de la Société d'Encouragement* (vol. cx., No. 6) there is an interesting paper on the combat against fire-damp and carbonic oxide in collieries by Prof. N. Gréhant, in which illustrations are given of the fire-damp detector designed by the author. In the same issue Mr. S. Wologdine has a note on the heat-conductivity of refractory materials.

The recent engineering and manufacturing development of Sweden has been rapid. With the opening of the railway through the rich iron-ore fields north of the Arctic circle and the extension of hydroelectric installations are now allied many important ship-canal and other projects, which are fully described in a profusely illustrated article by Mr. J. G. Leigh in the *Engineering Magazine* (vol. xxxv., No. 4). Another interesting article in the same number deals with the new processes for metal cutting and autogenous welding.

At the installation of Dr. W. F. M. Goss as dean of the college of engineering of the University of Illinois, several interesting addresses were delivered, which are now published in a Bulletin (No. 21) of the University. The subjects dealt with were:—significant events in the development of the college of engineering, by Prof. Ira O. Baker; on the standing of the technical graduate in the engineering profession, by Mr. W. L. Abbott; on the State College of Engineering, by Prof. W. F. M. Goss; on the value of engineering research, by Mr. R. W. Hunt; and on the need of graduate courses in engineering, by Mr. Willard A. Smith.

A paper on rail corrugation, read by Prof. C. A. Carus-Wilson before the Tramway Congress on July 10, is reprinted in *Engineering*. The investigations outlined appear to show that the following conditions are necessary for the formation of corrugations on grooved rails:—(1) in the track (*a*) irregularities in gauge or level, (*b*) curvature, or (*c*) a packed groove; (2) a rail surface rough with sand or gritty dust; (3) wheels with check-cutting flanges; and (4) a critical speed. Corrugations cannot be formed unless conditions (1), (2), (3), and (4) are all present at the same time. These considerations suggest the lines on which it may be possible to avoid the formation of corrugations.

The use of concrete and reinforced concrete pipe for culverts in railway embankments has suggested to Prof. A. N. Talbot an elaborate series of experiments, described in Bulletin No. 22 of the University of Illinois. The results throw light upon the resistance of pipe to embankment pressures, and also upon the action of sewers under similar conditions. Cast-iron pipes, concrete pipes, and reinforced concrete pipes were tested. The specially prepared testing apparatus used included a box of strong and stiff construction, and the pipes were embedded in sand, and the load applied through a saddle which rested on a sand cushion. Auxiliary tests were made to connect the results of the investigation with the strength of the materials.

In a paper on space and mathematical reasoning (*Mind*, xvii., 67, July), Mr. Leonard J. Russell discusses the theories of Poincaré and Russell, and puts forward a view of space on the analogy of number, empty space being found to have just such a significance as pure number has.

In a note contributed to the *Rendiconti del R. Istituto Lombardo* (2), xli., 11, on problems and methods of metallography, Dr. Gaetano Maderna urges the importance of metallographic researches, and directs attention to the fact that this branch of study has been neglected in Italy, both by the Government and private firms.

Prof. Fausto Morini contributes to the *Rendiconto* of the Bologna Academy a short note on a monstrosity in the fern *Aspedium lobatum*, var. *angulare*, Metten, found in the Apennines of the Bologna region. One of the lateral segments of the leaf is replaced by a very tiny leaflet devoid of sori, but possessing all the characteristics of an entire leaf, and the author considers that this monstrosity is due to the development of an adventitious gemma, the subsequent development of which has been limited to the formation of the leaflet in question.

In the *Atti* of the Naples Academy of Physical and Mathematical Sciences, xiii. (1908), Prof. G. de Lorenzo discusses the origin of the volcanic craters of the Capo Miseno and the island of Nisida. The papers are illustrated by photographs, and the observations point to somewhat similar conclusions in both cases, namely, that the craters were caused by eruptions at first submarine in character, but ultimately rising into the air, and that the erosive action of air and water, and in particular of the sea, is accountable for the present configuration of the harbours in question.

Two papers dealing with considerations relating to statistics and probability have reached us. In the *Statistical Journal*, Prof. F. Y. Edgeworth (June 30) discusses the probable errors of frequency constants. The author alludes to the objections that have been raised to the use of the term "probable error," and examines the evidence for the existence of an index of credibility of this character from the consideration of a number of different problems. A recently issued number (Studies in National Deterioration, part iii.) of the Drapers' Company Research Memoirs contains a paper by the late Ernest G. Pope on marital infection in tuberculosis. While Prof. Karl Pearson in his editorial criticisms deviates in several points from the opinions expressed by Mr. Pope, it may be safe to infer from the statistics that the effect of infection on the coefficient of correlation is less than the effect which may be attributable to "assortative mating."

Mr. J. W. Giltay, of Delft, writes to say that the optical illusion, mentioned by Dr. Terada in Nature of July 16 (p. 255), and also in the following issue (p. 277), reminds him of a similar effect noticed some weeks ago when witnessing a bicycle race at the velodrome at Scheveningen. "After having looked for some time at the racers, I casually looked at the spectators: the whole range of benches with the spectators appeared slowly to slide around, in a direction contrary to that moved in by the racers."

MESSRS. GEORGE BELL AND SONS have published a third edition of Mr. W. M. Baker's "Elementary Dynamics." Except that a number of minor corrections have been made, this edition appears not to differ from the second.

WE have received the forty-first volume, that for 1907, of the Journal and Proceedings of the Royal Society of New South Wales. The meetings of the society are reported from time to time in these columns under "Societies and Academies," and it is sufficient to direct attention to the publication of the annual volume.

## OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN AUGUST:—

Aug. 1. 11h. 28m. Minimum of Algol ($\beta$ Persei).
4. 8h. 17m. " " "
8. 6h. 41m. to 7h. 54m. Moon occults 4 Sagittarii (mag. 4·6).
9. 8h. 31m. Moon in conjunction with Uranus (Uranus 0° 24′ N.).
10–12. Maximum of the Perseid meteors (Radiant $45° + 57°$).
11. 12h. Venus at greatest brilliancy.
14. 23h. 53m. Moon in conjunction with Saturn (Saturn 2° 46′ N.).
16. Saturn. Outer minor axis of outer ring $= 5''·84$. Polar diameter of ball $= 17''·6$.
18. Venus. Illuminated portion of disc $= 0·327$.
24. 10h. 0m. Minimum of Algol ($\beta$ Persei).
27. 0h. Vesta in conjunction with Moon (Vesta 0° 21′ S.).
31. 3h. Ceres in conjunction with Moon (Ceres 0° 31′ N.).

EARLY PERSEIDS.—Mr. Denning, at Bristol, observed the first traces of the great August meteor shower on July 21, but no signs of it were apparent during watches maintained over a part of the nights of July 18 and 19. On July 25 meteors were very rare in a beautifully clear sky, but on July 22 and 26 they were numerous, and supplied evidence of several active minor showers at $298° - 15°$, $280° + 57°$, and $303° + 24°$. On July 26 the Perseid display had assumed very decided prominence, for it furnished during the two hours preceding midnight about four meteors per hour within the sphere of vision commanded by a single observer. The radiant point appeared diffused over an area with centre at $25° + 53°$, which agrees very nearly with the computed place of the shower centre on July 26.

A bright flashing Perseid, nearly equal to Jupiter, was recorded at 10h. 23m. on the night mentioned crossing the Milky Way in the south-west region of Aquila, the path being from $287° + 3°$ to $278° - 11°$, where it left a bright streak for a few seconds. A bright star meteor from a southern radiant was seen at 11h. 33m. moving from $350° + 6°$ to $17° + 20\frac{1}{2}°$, and at 11h. 49m. an Aquarid shot upwards close to $\gamma$ Pegasi. A radiant at $45° + 85°$, near Polaris, became well defined on the same night.

LARGE METEORS FROM SCORPIO.—In a letter to the July *Observatory* (p. 287, No. 398) Mr. Denning directs attention to the recent apparition of several large meteors coming from a radiant apparently situated in the constellation Scorpio. So far back as June 7, 1878, Mr. Denning's attention was directed to this radiant by the appearance of a large meteor, and since then he has regularly observed it, and has seen several very attractive meteors from it.

This year two fireballs from this radiant were observed, on May 19d. 10h. 20m. and May 22d. 8h. 50m. respectively, and duplicate observations show that the former passed over Ireland, from Ballyteigne Bay to co. Mayo, at a height of about sixty-nine to forty-five miles, along a path 142 miles in length; the radiant was in the region of 252°, −22°. Mr. Denning suggests that observations of this radiant in future years will amply repay the observers by providing them with brilliant meteoric phenomena at a season of the year when such phenomena are neither plentiful nor conspicuous. On the day of the partial solar eclipse, June 28, Mr. Denning saw a magnificent meteor, directed from Scorpio, which occupied seven seconds in passing from 276°, +23°, to 1°, $+48\frac{1}{2}°$, and cast off a bright trail of yellow sparks.

THE RECENT NIGHT-GLOWS.—Several accounts of observations of the night-glows which were seen, about the beginning of the present month, by observers throughout mid-Europe appear in No. 4262 of the *Astronomische Nachrichten* (p. 239, July 16).

Prof. Weber, of Kiel University, reports that no marked, irregular oscillations of the magnets were registered, but from June 27–30 small regular oscillations of 2′ amplitude and 3m. period were observed at intervals, and were not ascribable to any recognised cause.

Herr Köhl, of the Carina Observatory, Denmark, suggests that the solar illumination of cometary dust in the higher atmosphere might account for the phenomenon, and in this connection directs attention to the fact that several very large meteors were recently observed in Denmark.

Herr N. Donitsch states that on June 30 a fine aurora borealis was seen at Starya Doubossary, Bessarabia, and was visible from 11h. 10m. p.m. (local time) until dawn. The maximum illumination was a few degrees east of north, and suffered several variations; filaments, changing rapidly in form, were also seen.

DOUBLE-STAR MEASURES.—No. 4261 of the *Astronomische Nachrichten* contains further micrometer measures of double stars made by Prof. Burnham since the publication of his General Catalogue. The main idea of these observations is to establish beyond doubt the existence, or absence, of relative change of any kind in the lesser known and often neglected pairs. With this idea, the present list, as did the former, contains a note on each system indicating the nature and amount of any change which has been discovered.

THE HISTORY OF LUNAR RELIEF.—Charged with the task of bringing to completion the Lœwy-Puiseux "Atlas photographique de la Lune," M. Puiseux is preparing the text which is to accompany the work. Whilst studying the photographs for this purpose, he has been struck by the peculiar formations surrounding the northern pole of our satellite, and finds in them and their structure a possible key to the history of lunar formations in general. These rectangular formations, prominent in the region of Anaxagoras, M. Puiseux concludes to be typical of the earlier types of lunar structure, since modified, in other latitudes, by subsequent action, and he shows in a note published in No. 2 of the *Comptes rendus* (p. 113, July 13) how they were probably formed by the contortions of the thin superficial crust. M. Puiseux does not, in the present note, discuss the reason why the period of structure-formation should be a function of latitude, but points out that in this respect the earth affords a parallel case.

## MINERALS, INCLUDING GEM-STONES, AT THE FRANCO-BRITISH EXHIBITION.

SCIENCE and commerce regard minerals from two very different points of view, and many of the specimens to which much prominence is given at the Franco-British Exhibition—such as, for instance, the ubiquitous masses of silver-bearing galena—would find no place in a purely mineralogical collection. Commerce is concerned only with the ore value of the specimens, and attaches no importance to the presence of crystals or to their form and symmetry. On the other hand, in a museum specimens are arranged by the most interesting or the best developed species displayed on them, and it is impossible to realise at a glance what precisely are the minerals found in some particular quarter of the globe. Thus collections that are representative of the mineral products of various countries cannot fail to be of interest, from whatever point of view they may be considered; moreover, here and there the mineralogist will note with appreciative eye a well-crystallised specimen.

Most of the minerals will be found at the far end of the extensive grounds in the spacious halls of the Dominion of Canada and the Commonwealth of Australia. In the former, a singularly tasteful hall, the collection of minerals is the property of the Government, and is permanently kept together for sending to great exhibitions in order to testify to the mineral resources of the country; specimens are added from time to time to replace breakages and to represent newly opened mines. The small specimens are arranged in flat table-cases; of the large specimens, the more valuable are placed in large upright cases, and the remainder are piled near by in the open court. Information as to the nature of the ore, and in some instances the minerals present and the locality, is given on the labels accompanying the specimens. We may pass over the gold specimens from British Columbia and the Yukon district, and direct attention to the extensive series of silver associated with smaltite, niccolite, erythrite, &c., from the rich mines of Temiskaming, Ontario, first discovered five years ago. Some large crystals of phlogopite and apatite, and a small polished piece of beautiful blue sodalite, may be noticed.

In the Australia Hall the several component States have worked in their own courts independently, and not always on similar lines. In the Western Australia court the organisation and arrangement of the minerals have been managed entirely by the Government, and the result, as regards both the type of show-case and the selection and labelling of the specimens, is admirable. The gold industry naturally takes a prominent position. Some rich specimens of tellurides are shown, but they reveal no signs of crystal form. At the somewhat analogous district of Cripple Creek the telluride of gold, calaverite, occurs in many-faced crystals, the symmetry of which has been such a baffling problem. The tantalite from Greenbushes is interesting as the source of the filament of the new electric lamp; generally it is found in curiously marked massive pieces, but one or two specimens show unmistakable indications of crystal form. A huge lump, said to be only a portion of the original mass, testifies to the size attainable by tin-stone. At the principal entrance to the Queensland court are placed cases containing both rough and cut examples of the gem-stones found in the southern and central districts, viz. opal, colourless topaz, green and yellow sapphire, pink and green tourmaline, and pale green beryl. Conspicuous among them is the novel "black opal," which is of various shades to the deepest blue, and flames with vivid opalescence. Among the ore specimens at the further end of the court may be noted a bright wolframite and a fine bismuth. The gem-stones occurring in New South Wales are very similar to those just mentioned; perhaps the best black opal, of which some exceptional specimens are exhibited, comes from Lightning Ridge. Few good specimens from the famous Broken Hill mines are to be seen, and the arranging and labelling in at least two of the show-cases leave much to be desired.

Time, unfortunately, has not permitted of the organising of a collection of typical minerals in the India Hall. The Ruby Mines, Ltd., however, exhibit a magnificent series of rough and cut rubies and sapphires from Burma; no attempt is made to distinguish between the species corundum and spinel. Those interested in minerals will find much to attract them in the finely-crystallised specimens from the new lead and zinc mines at Broken Hill, North-Western Rhodesia, exhibited by Mr. Percy C. Tarbutt in the British Science Hall. They will see the zinc phosphates, hopeite, previously to the discovery of these mines known only by a few rare crystals, and tarbuttite, a new species, which was named after the exhibitor by Mr. L. J. Spencer, who recently described this remarkable mineral occurrence. In the same case Mr. Arthur Russell shows some minerals from the British Isles, mostly from abandoned mines or unrecorded localities, and Mr. F. N. A. Fleischmann exhibits a series of zeolites from the basaltic lava near Belfast.

Probably never before has such a superb collection of fashioned gem-stones been brought together for public view as are exhibited in the French and British Applied Art Halls. Space, however, permits us to direct attention only to the remarkable series of coloured diamonds exhibited by M. Eknayan in the former hall.

G. F. H. S.

## PROTECTIVE DEVICES FOR HIGH-TENSION TRANSMISSION CIRCUITS.

IN the Journal of the Institution of Electrical Engineers issued in June (vol. xl., No. 189), Mr. J. S. Peck describes some methods in use for protecting high-tension transmission circuits from lightning and other high-voltage discharges. The development of apparatus for this purpose has received little attention in Great Britain owing to the fact that there are comparatively few overhead systems working at pressures greater than 11,000 volts, and severe thunderstorms are of very rare occurrence. On the Continent and in America, however, where very high voltages are used in overhead systems, and where thunderstorms are more frequent and severe, it has been essential for the success of transmission to develop considerably such protective devices.

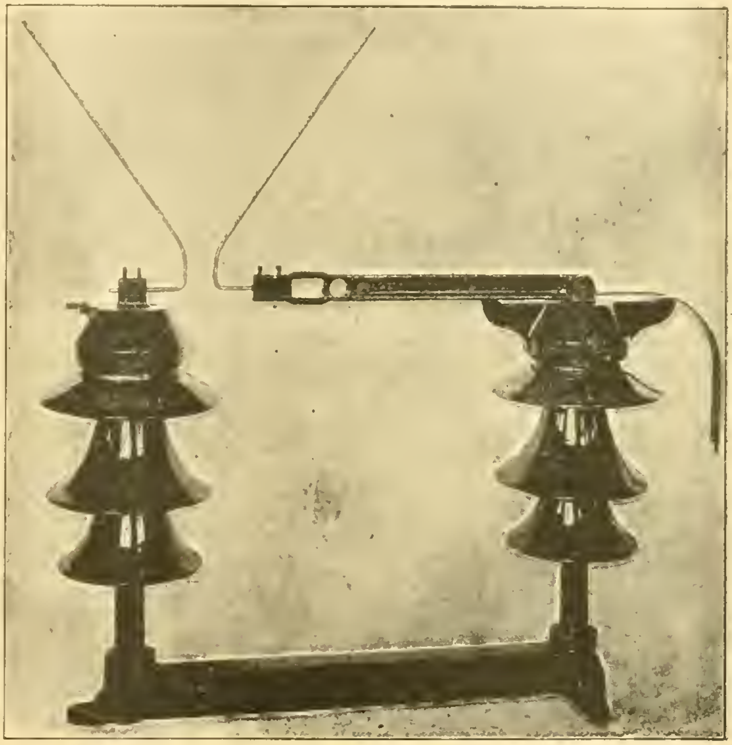


FIG. 1.—Horn-type gap.

Generally speaking, the effect of a lightning discharge on the circuit will be to cause a large increase of potential at certain points. Should the line insulation be insufficient, the charge may jump to earth, shattering poles, but probably protecting the apparatus at the end of the line from damage. If there is no escape in this direction, then there is the possibility of the insulation of the end apparatus breaking down, which is very serious.

Similar dangers may arise from sudden shorts in the system itself, and in dry climates the wind blowing over the transmission wires has been found to build up a high static potential. It is essential, then, to devise apparatus (1) to prevent concentration of potential at the end windings, and consequent shorts between adjacent turns; (2) to prevent excessive voltage between the wires and ground, causing breakdown to ground over insulators. To avoid (1), recourse may be had to high insulation, but this is not always practicable, and generally well-insulated choking coils are placed between the line and the terminal apparatus. If these break down they may be easily taken out and repaired. For (2), "lightning arresters" must be used. The essentials of such an arrester are that it must form an easier path to earth than the insulation resistance of the transmission line or other parts of the apparatus, and yet it must hold back the line voltage. There must, in addition, be some device for suppressing the arc which accompanies the discharge.

One of the earliest forms of arrester was the horn type (Fig. 1). This consists of two wires, one connected to line and the other to earth. Each is bent at an acute angle, so that they diverge from one another vertically upwards. Their distance apart at the lowest point must be adjusted so that no arc will occur for small increments of normal line voltage, but if the potential of the line connected wire rises considerably, an arc is formed. This arc rises, increasing in length, and is finally ruptured.

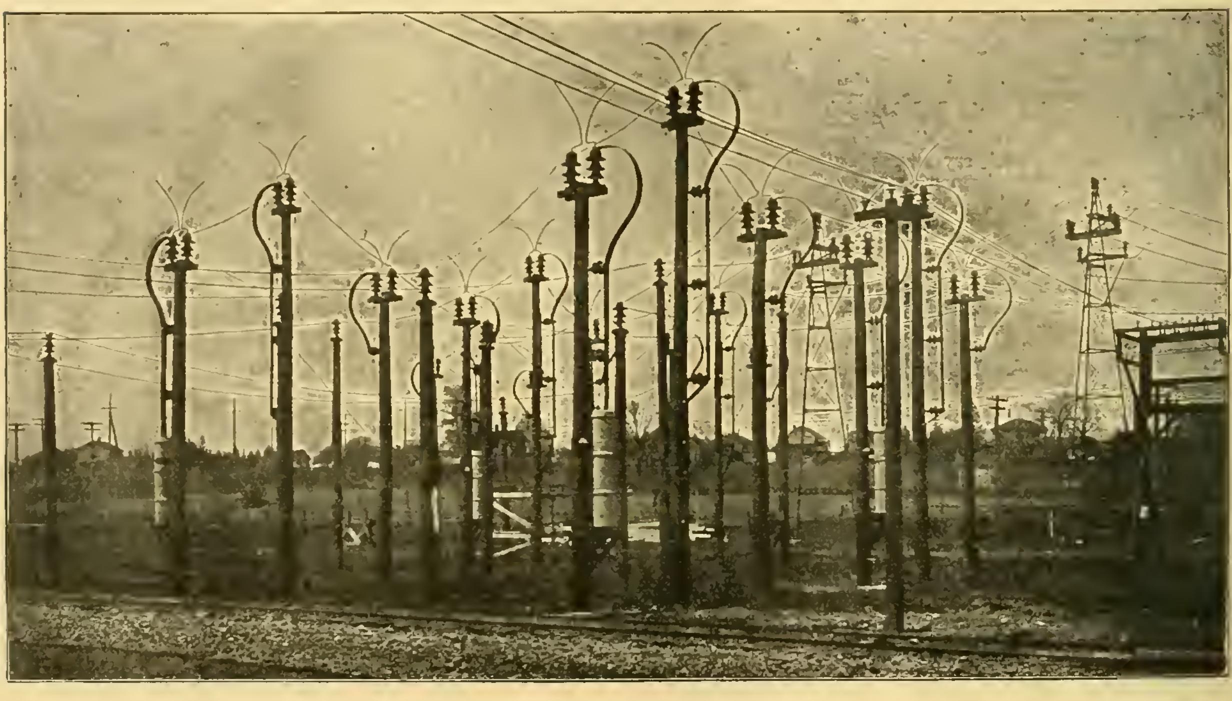


Fig. 2.—General view, 60,000-volt lightning arresters.

An objection to this form of arrester is the length of time elapsing between formation of arc and its rupture, for during this time the system is earthed. It is usual to place a high resistance in series with this arrester so that the current to earth from the line is diminished, but this will retard the static discharge. Owing to fusion of the metal at the lowest point where arcing occurs, it needs constant re-adjustment. An improved form is in use with an auxiliary gap and adjustable platinum point.

The "non-arcing multi-gap arrester" depends on the power certain metals have of suppressing an alternating arc. A number of cylinders of suitable metal are placed between line and earth. The cylinders are separated by gaps of 1/32-inch. They allow escape of the static charge, but no arcing occurs. These have proved most successful on low-voltage systems (2000 volts).

On the Continent, an arrester consisting of jets of water playing upon the line has been used. The chief objection to this is that it allows leakage of current from line to earth. The latest type of protecting device is the "electrolytic arrester." If aluminium electrodes are placed in certain electrolytes a non-conducting film is formed on the surface of the metal. This film can withstand a pressure of about 400 volts. At higher potentials it is punctured with a series of small holes, and the cell becomes conducting. When the excess voltage is removed the non-conducting film re-forms. By building up a number of such cells in series they may be made to withstand any desired voltage. Such a series is contained in a cylindrical earthenware vessel, the number depending on the normal line voltage, and is connected between line and earth (Fig. 2). It is usual to have a gap between line and electrolytic unit. For voltages not exceeding 13,500 volts, a non-arcing metal-cylinder gap may be used; for larger voltages one of the horn type is usual. Such arresters have been adapted successfully to lines with voltages varying from 4000 to 60,000 volts.

## THE ROYAL INSTITUTE OF PUBLIC HEALTH.

The annual congress of the Royal Institute of Public Health was held at Buxton from July 18–24. Among the many and varied subjects which were discussed, the following papers aroused considerable interest and discussion:—

Sir James Crichton-Browne took for his presidential address to the preventive medicine section "Parsimony in Nutrition." He did not concern himself with any particular dietetic system, but considered the general dietetic tendency towards abstemiousness which exists at the present day. Detailed reference was made to the dietary standards of Profs. Voit, of Munich, and Atwater, of the United States. These standards have been since found to be too high. An American, Mr. Horace Fletcher, showed that by careful and thorough mastication and insalivation the bodily needs are not only satisfied by a smaller amount of food, but the tone of the body is improved. Prof. Chittenden's careful researches on the subject led him to conclude that half the amount of proteids formerly considered necessary are quite sufficient. It was pointed out that before our dietetic system was revised on any such lines, it was essential to consider other facts. Concomitant with the proteid-consuming habits of the western races there had been a development of increased precision in mental operations, as seen in the rise and progress of the exact sciences. A liberal proteid input is serviceable in such morbid conditions as tuberculosis, hysteria, neurasthenia, &c. The evil influence of parsimony in nutrition has been shown by the researches into the condition of elementary-school children in large towns.

Mr. C. Gordon Hewitt read a paper on the biology of house-flies in relation to public health before a joint meeting of the preventive medicine and bacteriology sections. After a short description of the more important characters and the breeding habits of the species of flies that inhabit houses, the chief of which is *Musca domestica*, the public health aspect of the question was discussed. It had been proved that house-flies are able, if the necessary conditions were present, to carry the pathogenic bacilli of such infectious diseases as tubercle, cholera, anthrax, and those of an enteric nature. He contended that house-flies were not only able to be largely responsible for the dissemination of these diseases, but that summer diarrhœa, which was the greatest cause of infantile mortality, was largely due to the combined action of house-flies and unsanitary conditions. It was a striking fact that in places where the water-system of sewage disposal was used, the death-rate from infectious disease of an enteric nature was less than that of places where the older conservancy methods were employed. The study of the breeding habits indicated the means of reducing the evil for which they were responsible. In the discussion which followed, a number of members referred to the connection between flies and infantile diarrhœa.

Dr. C. W. Saleeby contributed a paper on racial hygiene or negative eugenics. He advocated the forbidding of parentage to the drunkard, the chronic inebriate, or the dipsomaniac. Our studies might now be extended, he thought, from the hygiene of the individual to that of the race.

The spread of tuberculosis by means of milk and meat was made the subject of several interesting papers which provoked considerable discussion.

Dr. A. M. Fraser showed that of the 60,000 people who die annually from tuberculosis, 11,000 are children under five years of age, that is to say, among the section of the community most dependent upon milk for its nourishment, 11,000 deaths occur from the disease. It has been demonstrated that 10 per cent. of the milk sent in churns to the cities of Liverpool, Manchester, Leeds, Birmingham, and Sheffield is infected with tubercle bacilli. Meat affected with tubercle is systematically sold in the markets for human consumption. He suggested the systematic inspection of farms by qualified veterinary inspectors and the elimination of tubercular animals; also, the improvement of the conditions under which the cows lived.

Prof. Cameron stated, in the discussion, that he believed town milk was freer from tubercle bacilli than country milk, and that the latter was contaminated before it left the country.

Mr. Thomas Ryan read a paper before the engineering and architectural section on radio-activity in water from hot springs. As Strutt has found that the residue deposited in the Buxton and Bath hot spring waters, he was of the opinion that the Buxton water contained radium emanations, which view, he said, was supported by the fact that a large amount of nitrogen was present in the water. He urged further research on the subject.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

CAMBRIDGE.—Prof. W. J. Pope, F.R.S., professor of chemistry and head of the chemistry department in the Municipal School of Technology, Manchester, has been elected to succeed Prof. G. D. Liveing, F.R.S., in the chair of chemistry.

LONDON.—At the meeting of the Senate on July 22, Dr. H. A. Miers, F.R.S., was appointed principal of the University in succession to Sir Arthur Rücker, F.R.S., who retires on September 30. Dr. Miers is at present Waynflete professor of mineralogy at Oxford, and fellow of Magdalen College. He has had a good deal of administrative experience at Oxford, being a member of the Hebdomadal Council, a delegate of the University Press, a delegate for the inspection and examination of schools, and secretary to the delegates of the museum. He served on the council of the Royal Society, 1901–3, and is at present president of the Mineralogical Society and of the Public Schools Science Masters' Association. He was educated at Eton and Trinity College, Oxford, and after graduating served as assistant in the British Museum (1882–95), and as instructor in crystallography at the Central Technical College (1886–95). He was appointed professor of mineralogy at Oxford in 1895, and is now fifty years of age.

Important modifications have been made in the regulations in medicine for internal and external students. After January, 1909, there will be three examinations for medical degrees (M.B., B.S.)—the first, second, and third. The first examination (replacing the preliminary scientific examination, part i.) will still consist of chemistry, physics, and general biology, but new syllabuses, of a more professional character, have been approved. The second examination will be in two parts, part i., organic and applied chemistry, and part ii., anatomy, physiology, and pharmacology, including pharmacy and materia medica. The third examination for medical degrees is similar to the present final examination, which it replaces. The whole course, both for internal and for external students, will extend over at least five and a half years, of which at least three must be devoted to the final subjects. After July, 1909, the scholarships at present offered for anatomy, physiology, and pharmacology will be withdrawn.

The Imperial College of Science and Technology has been admitted as a school of the University in the faculties of science and engineering.

The Royal Army Medical College, Millbank, has been admitted as a school of the University in the faculty of medicine for officers of the Royal Army Medical Corps.

The following degrees have been granted:—D.Sc. in physiology to Miss Winifred Cullis, an internal student of the London School of Medicine for Women; D.Sc. in physics to Mr. S. W. J. Smith, an internal student of the Royal College of Science; D.Sc. in zoology to Mr. W. N. F. Woodland, an internal student of University and King's Colleges; D.Sc. in zoology to Mr. R. E. Lloyd, an external student of University College, Marine Survey, India, and Indian Museum; D.Sc. in geology to Mr. T. F. Sibly, an external student of Birmingham University; B.Sc. by research in chemistry to Mr. Jacob Fox, East London College.

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DR. NANSEN has been elected professor of oceanography at the University of Christiania.

THE Society of Merchant Venturers has decided to petition His Majesty in Council in favour of the grant of a charter for the establishment of a University of Bristol on the lines of the draft charter prepared by the local university college, but suggesting certain modifications, which will define more precisely the position in the University to be occupied by the university classes of the Merchant Venturers' Technical College. Among the most important are those which provide that Bristol students whose means are small shall still be able to obtain a university education at fees as low as those charged by the Merchant Venturers' Technical College, and that the degrees of the University shall be open to evening students.

THE Royal Commissioners of the Exhibition of 1851 have appropriated the whole of the remaining site of their estate at South Kensington for the purposes of the Imperial College of Science and Technology. This announcement was made at a meeting of the governing body of the college on July 24. The question of the provision of additional buildings and laboratories on the sites granted by the Commissioners was under consideration, and it was decided, in the first instance, to proceed at once with the provision of new mining and metallurgical buildings for the Royal School of Mines, and to invite Sir Aston Webb, R.A., to serve as architect to these buildings and of such other buildings as the governing body may determine to erect. The Hon. R. J. Strutt, F.R.S., was appointed by the governors additional professor of physics, and Mr. S. Herbert Cox as full-time professor of mining. An additional professor of zoology, a professor of metallurgy, and an assistant professor of botany are to be appointed shortly.

THE Manchester Microscopical Society is doing some excellent pioneer work through the agency of its extension section, the objects of which are to spread the knowledge of microscopy and natural history among outside associations by means of lectures and demonstrations. We have received a copy of the society's lecture list for 1908–9, and find that local associations in or near Manchester may select from forty-seven lectures on botanical, zoological, and nature-study subjects, which certain members of the society are willing to deliver gratuitously. The associations securing the services of lecturers are expected to pay for hire of lantern-slides, travelling and out-of-pocket expenses only. The Manchester Microscopical Society is to be congratulated upon its efforts to bring scientific knowledge, in a popular form, before associations of persons anxious to be instructed. Full particulars of this enterprising scheme may be obtained from Mr. R. Howarth, honorary secretary of the section, 90 George Street, Cheetham Hill, Manchester.

WE have received from Prof. L. Weber, of the University of Kiel, a copy of his report to the Magistrate of Kiel on the daylight illumination of the various primary and secondary schools of the town, thirty-four in number. At each of these schools measurements have been made of the illumination of a surface placed horizontally on desks selected as the best, medium, and worst illuminated, in about four of the most representative of the rooms of the school, on days when the illuminating power of the sky was known. In addition, the solid angle subtended by the portion of sky visible from each of the three desks, and that subtended by the sky visible from the middle window of each of the rooms tested, were observed. The report contains a description of the apparatus used, and details of some of the most interesting cases are given. Prof. Weber considers that an illumination equal to thirty candles at a metre distance throughout the darkest month should be taken as a minimum, and on this basis about 5 per cent. of the rooms tested are deficient, and should be improved by the provision of larger windows or by the trees in front of the windows being trimmed. In congratulating Kiel on the wisdom it has displayed in having an investigation of this kind carried out, one is tempted to ask whether any town of the size of Kiel in this country has ever thought it worth its while to have such measurements made, or is everyone too much absorbed in the educational controversy to think of the eyesight of the child?

EARL PERCY took part in the debate on the Indian Budget in the House of Commons on July 22, and in his speech gave a prominent place to the problems of Indian education. After instituting a comparison between the conditions of elementary education in this country and in India, he said that in England our system of education is directed towards preparation for an industrial career. In India almost the only industry is agriculture, but the system does nothing to qualify the people for their calling in life, and any special aptitude finds no outlet except in the law or in Government employment. Speaking of technical education, he remarked that it is seven years since a conference at Simla went into all the phases of Indian education, primary, secondary, and technical, and passed an enormous number of resolutions, upon which it was expected prompt action would have been taken. The resolutions dealt with the neglect of the study of the vernacular, recommending that it should be carried on throughout; that the results of examination should be taken as passports to the universities and Government employment; that in secondary schools a modern side should prepare pupils for a commercial career; that relations should be established between school authorities and chambers of commerce; and, lastly, the subject of technical education was dealt with in a valuable report. Industrial institutions were recommended for the different provinces connected with special local industries, with a system of apprenticeship in workshops under the supervision of Europeans, and the training of village schoolmasters in tillage. Are we really making substantial progress in any of these directions? he asked, and answered the question by saying the whole reforming energy of the Government seems to have been directed to the universities. The increase in educational expenditure has taken place on too low a basis; the total amount is almost insignificant. How can we ask the Indian to believe that his own Government, which in the last three or four years has sacrificed three or four millions of revenue from the salt duty and opium, and is contemplating large borrowing powers, cannot find money enough to spend on the development of technical education, which is of vital interest if the people of India are to be prepared to take their proper part in the development of industries? With regard to the general administration of education, Earl Percy thinks we shall never get any real enthusiasm or progress until the administration is reformed. There is now a director-general of education, but it is still the fact that, not only is there no member for education in the Viceroy's Council, but the director-general, if he wishes to bring any educational matter before the member who represents the home department, has to do so through the ordinary machinery of the office. Earl Percy expressed the opinion that, having a member on the Council directly representative of and responsible for education, the director-general ought to be given the same right and privilege of free access to the Viceroy which it is proposed to give to the new President of the Railway Board.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, May 7.—"Seleno-aluminium Bridges." By Prof. George M. **Minchin**, F.R.S.

A seleno-aluminium bridge consists of two plates, P, Q, of aluminium separated by a very thin flake of mica and having a thin layer of sensitive (or conducting) selenium spread across one edge of the mica and the two adjacent portions of the aluminium plates. We have thus the separator of mica bridged over by the selenium, which, of course, adheres to the two aluminium plates. If before the bridge of selenium connected these plates, P, Q, the plates were connected in series with a battery and a galvanometer, no current would flow, but when the selenium bridges over the mica separator, the current passes. Let $C_0$ denote the strength of this current when the bridge is completely screened from light. $C_0$ will, of course, depend on the voltage of the battery and the thickness of the mica separator, as well as on the length of the edge of mica covered by the selenium.

If now the selenium layer is exposed to light, the current will be increased—multiplied five times, or more, if daylight is allowed to fall on the selenium.

Owing to the extreme thinness of the mica, the intensity of the light along any line of a spectrum (say that of a star) can be measured if we know the way in which the current-strength, C, depends on the intensity, $i$, of the light. The main object of experiments carried out recently in the electrical laboratory at Oxford was to discover the relation between C and $i$. After many assumptions of the form $C=C_0+k\sqrt{i}$, and others, it was found that no such assumptions satisfy the observations, but that an equation of the form $\log\frac{C}{C_0}=ki^n$, where $k$ and $n$ are constants for the particular kind of light employed, agrees very well with experiment. Thus, suppose that we are using red light of a particular wave-length, let $C_1$ be the value of current when the intensity of this light is $i_1$, and let C be the current when the intensity is $i$; then our equation is

$$\log\frac{C}{C_0}=\left(\frac{i}{i_1}\right)^n\log\frac{C}{C_0}\quad . \quad . \quad . \quad . \quad . \quad (1)$$

The red light employed was that obtained by passing the light of a Nernst lamp through a thick column of water (to cut off heat), and then through a solution of fuchsine. This light was passed along a dark cylinder 6 metres long, the length of which could be varied by removing metre lengths successively, and, as the selenium bridge was at one end of this cylinder, $i$ was varied. Blue light was also used in this way, and it was found that $n$ is not the same for blue as for red: for the first $n=0.36$, and for the second $n=0.25$, nearly. Thus it appears that the method of measuring light which consists of various colours by exposing a selenium resistance to the compound light is erroneous; the light must be broken into a spectrum, and the intensity measured in each part.

A selenium bridge possesses the peculiarity (which was noticed by Adams and Day in their experiments) that, once it has been exposed to light, while a current is passing through it, its resistance is not the same to currents passing in one direction as to currents passing in the opposite direction, and apparently the two resistances never again become equal.

Moreover, the resistance to a current of given direction *depends on the voltage*. It was found that if $c$ is the conductivity of the bridge when the voltage of the battery is V,

$$c=kV+k', \quad \ldots \ldots \quad (2)$$

where $k$, $k'$ are constants. Thus the conductivity is a linear function of the voltage, but this will not be found unless the observer allows the current to run for several minutes. When light falls on the bridge, the current produced increases as the exposure is continued. With red light the current rises very rapidly, and after, perhaps, forty-five seconds moves slowly towards an asymptotic value. With blue light the rise of current at the instant of exposure is much slower. The curve the ordinates of which are the values of C and abscissæ the times, $t$, has an equation of the form

$$(H-C)^{-m}-(H-C_0)^{-m}=\lambda t, \quad . \quad . \quad . \quad (3)$$

where H (the final value of C), $m$, and $\lambda$ are constants depending on the colour of the light.

The curve is hyperbolic in appearance.

Finally, a spectrum was formed by passing the light of the Nernst lamp through quartz lenses and prisms, and it was found that the effect is a maximum in the red near the yellow, and that effects are produced in and a little beyond the violet, while at the infra red end the effects extended to more than a whole spectrum length. The radiation of a very hot, but invisible, metal ball produces scarcely any effect, even at a small distance from the bridge.

**Geological Society**, June 17.—Prof. W. J. Sollas, F.R.S., president, in the chair.—The hornblendic rocks of Glendalough and Greystones (co. Wicklow): J. Allan **Thomson.** Both these rocks are intrusive into Ordovician strata in the east of county Wicklow, the former occurring as a small boss in the south side of Camaderry, a ridge which separates the Vale of Glendalough from the valley of Glendrosan, while the latter occur as three dykes traversing the sedimentary rocks on the shore at Greystones. The Glendalough rock is older than the Great Wicklow Granite, and exhibits much heterogeneity in composition. The Ordovician sediments are converted into hornfels at the contact with the igneous rock, and this type of rock has resisted the dynamic metamorphism which occurs elsewhere in the district. The Greystones rock shows a transformation from peridotite into amphibolite, but with a greater development of talc. Olivine and rarely mica are present in the original rock.—On the occurrence of footprints in the Lower Sandstones of the Exeter district: A. W. **Clayden.** Suitable exposures in the "Lower Sandstones" of the Geological Survey map are very rare. Dr. Shapter has recorded "claw-like footmarks," &c., from a locality about half a mile north-east of Broadclyst. Another quarry has been recently re-opened here for building-stone, and, on a search being made, slabs with footprints were found by the author and his students. Later, a slab with a track containing thirty pairs of footprints was found. In all, five specimens have been secured, and three of the sets of prints may have been made by the same individual, one with fore and hind feet about the same size and bearing about the same weight. The two other sets of prints were made by smaller and different individuals.—The basic intrusion of Bartestree, near Hereford: Prof. S. H. **Reynolds.** The Bartestree dyke, which has a thickness of about 35 feet, strikes in an east-north-easterly direction through the Old Red Marls and Sandstones, which for a distance of at least 10 feet from the contact are strongly metamorphosed, the marl being converted into a hard purplish-grey rock with yellow patches, while in the sandstone the felspars are re-crystallised and the quartz-grains corroded. The dyke itself is not a single uniform intrusion, but a multiple dyke composed of several allied though differing types of dolerite and basalt.

**Challenger Society**, June 24.—Prof. d'A. W. Thompson in the chair.—Oceanography in America: Prof. C. A. **Kofoid.** The recent traverses of the interesting stretch of ocean lying between the Galapagos and Easter Island, on the one hand, and the S. American coast on the other, made by Prof. Agassiz in the U.S. Fish Commission steamer *Albatross*, with which the speaker had been associated, were described in detail, and valuable conclusions drawn as to the influence of currents, up-welling, and eddies on the richness or poverty of both plankton and benthos. Some of the more important marine stations of the United States, and the character of their work, were also dealt with.

PARIS.

**Academy of Sciences**, July 20.—M. Bouchard in the chair.—The minerals from the fumaroles of the recent eruption of Etna, and on the existence of boric acid in the existing fumaroles of Vesuvius: A. **Lacroix.** One of the peculiarities of the recent eruption of Etna was the slight intensity of the fumaroles. The latter offered all the usual phenomena, with the exception that the warmest fumaroles contained no copper salts. Those containing ammonium chloride as the principal constituent also contained a notable quantity of fluorine. In the fumaroles of Vesuvius a small quantity of the mineral sassolite was found; this was identified by its hexagonal form, its optical properties, and its chemical properties, the last corresponding to normal boric acid.—The hydrates of strontia and baryta: M. **de Forcrand.** Strontium hydrate can be converted into the anhydrous SrO by heating for a long time in a current of hydrogen at a temperature of 850° C. BaO can be obtained in a similar manner in two or three hours at 780° C. Various intermediate hydrates are described and thermochemical data given.—Remarks on the note of M. Lebedew. The apparent dispersion of light in interstellar space: G. A. **Tikhoff.** Some new observations on the star RT Perseus, and a reply to the criticisms of M. Lebedew.—Ruled surfaces: M. **Tzitzéica.**—Algebraic functions of two variables: H. W. E. **Jung.**—The points of equilibrium of a fluid in movement: M. **Popovici.**—The periodic solutions of a functional linear equation: Ernest **Esclangon.**—The calculation of the tensions in articulated systems of three dimensions: B. **Mayor.**—A safety apparatus against continuous disturbing sparks in wireless telegraphy: Edouard **Branly.**—The flame spectra of calcium: G. A. **Hemsalech** and C. **de Watteville.** The finely divided substance, pulverised by the electrical method previously described by the authors, was introduced into various flames, air-coal gas, air-hydrogen, oxygen-coal gas, and oxygen-hydrogen, and the observed spectra compared with the arc spectrum (Kayser and Runge).—Variations in the fringes in the photochromes of the spectrum: E. **Rothé.** A study of the conditions necessary to free the photographs from the results of secondary phenomena. Photographs of spectra are submitted to the academy, in which the colours are pure, the exact reproduction of the colours of the spectrum, all the accessory reflections having been suppressed.—Electric and magnetic double refraction of nitrobenzene. Variation with the wave-length: A. **Cotton** and H. **Mouton.** In nitrobenzene, Kerr's phenomenon is exceptionally large, being ninety-seven times that of carbon bisulphide for the yellow mercury line. Within the experimental error of the experiments, the dispersion of the electric double refraction of nitrobenzene is the same as the dispersion of the magnetic double refraction.—A case of anomalous rotatory dispersion; application of the measurements of rotatory dispersion to the study of the composition of essence of turpentine: Eugène **Darmois.** Some mixtures of dextro- and lævo-rotatory turpentine show an anomalous dispersion: the rotation becomes zero for one colour of the spectrum, and passes through a minimum for another colour.—The reduction of alkaline chloroiridates by oxalates: Marcel **Delépine.** A reply to a claim for priority by M. Vèzes.—Researches on the ketodiacids: E. E. **Blaise** and H. **Gault.** By saponifying oxalsuccinic ester with cold hydrochloric acid, the authors have succeeded in obtaining α-ketoglutaric acid,

$$CO_2H—CO—CH_2—CH_2—CO_2H.$$

Attempts to generalise this reaction to the alkyl derivatives have not been completely successful.—A new crystallised sugar, perseulose, with seven atoms of carbon: Gabriel **Bertrand.** This new sugar has been obtained by the biochemical oxidation of perseite with the sorbose bacterium, particulars being given of the details of the operation. The sugar has the constitution $C_7H_{14}O_7$; it is lævorotatory, and shows the phenomenon of multirotation. Particulars are given of its reducing power and of its osazone.—The formation of compounds in solutions of tartaric acid and sodium molybdate: P. **Quinet.** The densities of the solutions, rotations, electric resistance, and cryoscopic constants have been studied. The graphical analysis indicates definite compounds between one molecule of tartaric acid and one and two molecules of sodium molybdate.—The alkaline granites of eastern Corsica: Pierre **Termier** and Jacques **Deprat.**—Urohypertensine: J. E. **Abelous** and E. **Bardier.** This substance is extracted from normal human urine by ether, and separated by means of oxalic acid. It acts as an energetic vaso-constrictor, principally of peripheric origin. The hypertensive substance acts by exciting the peripheric ganglia of the great sympathetic, and also, to a minor degree, the muscular fibres of the vessels.—The relative magnitude of the eye and the appreciation of encephalic weight: Louis **Lapicque.**—Contribution to the study of the nucleo-proteids. Researches on the constituents of pepsin: L. **Hugounenq** and A. **Morel.** The authors have applied the method of hydrolysis with hydrofluoric acid, described by them in an earlier paper, to the study of the nitrogenous substances obtained by the hydrolysis of pepsin. Thirteen of these bodies were isolated and their proportions given.—The semi-logical signification of urinary indoxyl. The examination of pus for indol: Ch. **Porcher.** The method for detecting indol in pus is given in detail. Twenty-five observations on pus of different origins showed indol in nine cases only, so that indol is not an invariable constituent of pus. It is noted that when indol occurs in pus it is never in minute quantities.—Researches on the pharmacodynamic action of cyclohexane and some of its derivatives: A. **Brissemoret** and J. **Chevalier.**—Researches on the presence of the rare gases in the atmosphere at various heights: L. Teisserenc **de Bort.** The samples were collected from captive balloons provided with an automatic apparatus for collecting the samples at different known heights. In all the samples, whatever the height of collection, a notable proportion of argon was found; helium was only found in the lower layers up to a height of 10 kilometres, neon being found in all the samples.

### Cape Town.

**Royal Society of South Africa**, June 17.—Mr. S. S. Hough, F.R.S., president, in the chair.—A new Transvaal tick, a variety of *Ixodes pilosus* (Koch): Prof. J. G. **Neumann.**—The distribution and hosts of the New Transvaal tick *Ixodes pilosus howardi*, Neum.: C. W. **Howard.** Mr. Lounsbury, in one of his reports, stated that *I. pilosus* was only found in the Cape Colony in places which were very humid, such as kloofs containing a stream of running water, or in the vicinity of vleis. Apparently, *I. pilosus howardi* was not limited in its distribution to these conditions, since Mr. Howard had taken specimens from places which were more or less dry, unless they could consider Durban as humid, but such places as Leydsdorp and Zoutpansberg, from which some of the specimens were taken, were very arid. The principal host was the dog, but at the Ivy Mine, Moodies, Barberton, a few specimens were found on a cat, and a few on a hedgehog at Pienaars River.—The occurrence of the genus Sphæroplea in South Africa: W. T. **Saxton.** The previously noted localities where the green alga Sphæroplea occurs are the inundated plains of Central Europe, Asia, and America. Specimens were collected in South Africa by Mr. Saxton in a freshwater pool on Dassen Island nearly two years ago, and again recently in pools on Green Point Common by Mr. E. P. Phillips. The alga is interesting as representing a monotypic and rather isolated family, and is the only one of its species known. Diagrams were shown illustrating the structure and life-history.—Some investigations regarding brak (alkali) in Cape Colony soils: Dr. C. F. **Juritz.** Brak or alkali in soil consisted of accumulations of sodium salts. Rainy weather carried them to varying depths, but prolonged dry weather caused their return to the surface. Irrigation tended to accentuate these conditions, hence the adaptability of any tract of country for irrigation depended, other things apart, upon the proportion in the soil of salts which might render it unproductive. To test a soil as to its liability to become brak under irrigation, it was essential to take samples at regular intervals all the way down from the surface to the greatest depth which irrigation water might penetrate. Brak was caused by carbonate, chloride, and sulphate of sodium, the first doing the most and the last the least injury. Natural drainage usually carried these noxious salts seawards, but this was prevented by (1) an impermeable layer below the surface forming a basin; (2) compactness of the soil itself, and (3) a high water-line in the subsoil. Even these obstacles, where frequent rain resulted in an even distribution of salts throughout the soil, were not always sufficient to prevent successful cultivation. The difficulty arose with a scanty rainfall and a warm climate, or long drought after heavy rain; then it became important to ascertain how much salt the soil could contain and still be successfully cultivated. Investigations had been made in the divisions of Herbert, Colesberg, Britstown, Steynsburg, Robertson, and Carnarvon.

## CONTENTS.

THURSDAY, AUGUST 6, 1908.

## THE WORK OF J. S. BUDGETT.

*The Work of John Samuel Budgett, Balfour Student of the University of Cambridge.* Being a Collection of his Zoological Papers, together with a Biographical Sketch by A. E. Shipley, F.R.S., and Contributions by Richard Assheton, Edward J. Bles, Edward T. Browne, J. Herbert Budgett, and J. Graham Kerr. Edited by J. Graham Kerr. Pp. x+494; 28 plates, 173 figures. (Cambridge: University Press, 1907.) Price 25*s.* net.

THIS stately volume is an appropriate tribute to the memory of Mr. J. S. Budgett, whose untimely death in 1904 was a sad loss to zoology. He was always one who loved hard work, and it is fitting that the memorial which his friends have raised as an expression of their esteem should consist of a reprint of his papers and of a working out of the valuable material which cost him his life. Budgett was a zoologist of the best type, combining the enthusiasm of the field-naturalist with the austerity of the morphologist, and "the patient persistence of his quest for the eggs of Polypterus under crushing difficulties forms one of the most courageous episodes in the history of zoology." "After years of patience, after three unsuccessful journeys into the heart of Africa, he at last succeeded where all others had failed." He had the joy of watching the development of this remarkable type, but it was for others to enter into his labours. He succumbed to malaria and blackwater fever a few days after he had finished his drawings of the external features of the developing ova. It seems a terrible price to pay for another chapter of embryology, yet Mr. Shipley reminds us in his sympathetic biographical sketch of a remark made by Robert Louis Stevenson, that "to be wholly devoted to some intellectual exercise is to have succeeded in life."

The book begins with the biographical sketch—good reading for all, for those in particular who are not too old to learn. Then follow the reprints of Mr. Budgett's zoological papers (1899–1903) on Polypterus and Protopterus, on the habits of other West African fishes, on Phyllomedusa and other Paraguayan batrachians, on the ornithology of the Gambia River, &c. His work was characterised by "an almost fastidious degree of accuracy," and is of enduring quality. "We owe to him the first accurate account of the urino-genital organs of Polypterus, and the demonstration that the crossopterygian fin is really a uniserial archipterygium; besides a series of invaluable observations upon the life-history and breeding habits of many tropical frogs and fishes."

In spite of Budgett's work, there is still lack of definite observations regarding the oviposition and fertilisation in Polypterus; it seems that the eggs are deposited in the shallow lagoons connected with the main river early in the rainy season; they apparently adhere strongly to submerged twigs or water-plants. There are certain peculiarities—such as the modified and erectile character of the anal fin of the male—which point to internal fertilisation, and in this connection we may refer to an interesting letter (p. 291) from Mr. J. Herbert Budgett on the supposed courtship. The young fry apparently accompany the parent (probably the male) in a dense swarm, very much as is the case in actinopterygian bony ganoids.

Prof. Graham Kerr has used to good purpose Mr. Budgett's collection of the eggs and embryos of *Polypterus senegalus*, and has worked out, what has been for so long a desideratum, a fairly complete picture of the general course of development in a crossopterygian fish. The memoir is a noteworthy example of careful and skilful morphological work. We cannot do more than refer to some of the interesting results.

The segmentation is complete, and in its earliest stages nearly equal; the invagination groove is at first nearly equatorial in position; as the curve described by the groove becomes closed an enormous "yolk plug" is formed; rudiments of external gills and cement organs appear at an early stage; the buccal cavity is for a while a widely-open space bounded by the cement organs, the lower side of the head and the cardiac region. The mesoderm of the trunk region arises as it does in Lepidosiren, Protopterus, and Petromyzon, by "delamination." A well-developed solid post-anal gut is present which eventually breaks up and disappears. The secretory epithelium of the cement organ is endodermic, arising as a pair of hollow enteric diverticula, which become cut off from the rest of the endoderm and establish a connection with the outer surface. The lung rudiment is median and ventral, and very soon develops asymmetry. The pancreas arises from three rudiments, and the liver is really a hepatopancreas—the pancreatic tissue being spread out over part of its ventral surface. The dorsal aorta arises from cells or protoplasmic masses derived from the sclerotom; its lumen is derived from the fusion of originally separate vacuoles in these masses; the endocardium appears to be mesoblastic in origin; the blood corpuscles appear suddenly, and it is suggested that they are mesenchyme cells set free by an epidemic of mitosis. The chondrocranium is amphibian-like in early stages.

The neural tube arises by overarching of the medullary folds; both infundibulum and optic rudiments are clearly recognisable while the medullary groove is still widely open throughout; as in Lepidosiren, &c., the brain is, during the earlier part of its development, subdivided into two—not three—regions, the primitive forebrain and the rhombencephalon; the pineal outgrowth is single, and without any eye-like structure; in the adult the cerebellum becomes highly developed and forms anteriorly a valvula cerebelli, while posteriorly it projects back in a quite similar manner into the fourth ventricle; the material forming the side walls of the thalamencephalon does not become pushed out to form cerebral hemispheres, but is accommodated partly by the great increase in length of the thalamencephalon, partly by its becoming invaginated into the interior of the third ventricle; the two olfactory rudiments are apparently connected by an ectodermal thickening across the middle line in early stages; the cavity of the olfactory organ is a secondary excavation in the originally solid rudiment.

Prof. Kerr does not enter into any elaborate discussion of the general import of the results reached, but some very interesting, more or less speculative, conclusions are suggested:—

(1) "On the whole the general phenomena of

development in Polypterus show frequent striking resemblances with what occur in Dipnoans and in the lower Amphibia. I believe these resemblances are sufficient by themselves to indicate the probability that the Teleostomes, the Dipnoans and the Amphibians have arisen in phylogeny from a common stem, which would in turn probably have diverged from the ancestral Selachian stock. The ancestors of the Amniota probably diverged either about one or about several points from the region of the stem common to Dipnoi and Amphibia."

(2) The external gills develop in Polypterus exactly as they do in Lepidosiren and Protopterus and in the more primitive Amphibia (Urodela and Gymnophiona), *i.e.* each one arises as an outgrowth from the outer side of the visceral arch (in this case hyoidean), composed of mesenchymatous core with ectodermal covering. They appear before the perforation of the gill-clefts, and are probably organs of great antiquity. The respiratory epithelium of the gill-clefts has arisen by a spreading inwards from the ectodermal respiratory epithelium of the external gills.

(3) It may be that paired limbs are homodynamous with external gills in which the potential motor function has been accentuated.

(4) As Budgett showed, the condition of the fin-skeleton in the 30 mm. larva of Polypterus indicates its close relationship to the type of uniserial fin-skeleton occurring in sharks. Prof. Graham Kerr briefly re-states the hypothesis that both can be referred back to a primitive biserial archipterygium like that of Ceratodus.

(5) In the evolution of the head there has been a varying amount of displacement in an anteroposterior direction of the relative positions of mesoderm segments and visceral pouches, and it is suggested that the enterocœlic pouches were once wholly posterior to the visceral pouches, and that the two structures are really homodynamous.

(6) The nervous material which corresponds with the whole of the cerebral hemisphere in the higher forms—including the pallium or mantle—lies in Polypterus in the thickened wall of the thalamencephalon. What is ordinarily called the pallium in a crossopterygian is simply the roof of the thalamencephalon, and the conditions in actinopterygian ganoids and teleosts are similar.

In the river Gambia Mr. Budgett found the "nest" of *Gymnarchus niloticus,* a primitive and at the same time specialised teleostean, belonging to the family Mormyridæ. He secured a fine series of the eggs at different stages, and these have been described by Mr. Richard Assheton in a remarkably fine memoir, which is the first contribution to the embryology of Mormyrids. Mr. Budgett gave an account of the floating nest with its thousand large eggs like amber-beads. The development is extraordinarily rapid, for the eggs hatched in seven days, and in eighteen days the young fry left the nest three inches long. Mr. Budgett thought that the development was "exceedingly shark-like," but this has not been borne out by Mr. Assheton's work. There is a large mass of yolk, and the larvæ have very long gill-filaments hanging down in two blood-red branches, but the development is on the whole typically teleostean. We can only refer to a few of the many interesting features.

The alimentary canal arises as a cleft among the hypoblast cells. At an early stage—or perhaps from the beginning—the whole of the pharyngeal region is without a lumen, and it does not get one until after hatching. There is one pair of true gill-clefts between the sixth and seventh visceral arches; the other "gill-clefts" of embryonic life are invaginations of the ectoderm which undermine the visceral arches. There are long external uniramous gill-filaments upon the first, second, third, and fourth branchial arches, which shrivel after the operculum has grown over them, excepting the proximal ends which give rise to the permanent gills. The whole apparatus is lined by epiblast from first to last.

The air-bladder, which arises as a single diverticulum of the œsophagus a little to the left of the mid-dorsal line, has right and left lobes, and is extremely lung-like. Its structure, its vascular supply, and the habits of the fish all point to its use as a lung. The yolk-sac is to be regarded as an appendage of the liver—due to the accumulation of yolk in that part of the egg which normally becomes the liver. The gall-bladder and liver arise by the constriction off of a large ventral recess of the alimentary canal (just posterior to the œsophagus); the pancreas is developed as diverticula of the bile-ducts (the constricted region just mentioned), and these grow backwards to mingle with the "islands of Langerhans" tissue and even with the spleen; the islands of Langerhans arise very early as a solid mass of epithelial tissue which becomes broken up by the splitting of the mesenteric artery.

There are certain features which suggest an earlier condition of teleostean evolution than is the case with other members of the class the development of which has been studied hitherto, and Mr. Assheton inquires whether Teleosteans may not be descended from a proto-amphibian race. He refers to the amphibian-like character of the lips of the blastopore, to the vestige of neural tube formation, to various features in the development of the excretory system, to the lung-like and vestigially double air-bladder, to the trace of an auricular septum and the suggestion of a double circulation, to the large size of the aortic arch of the fourth visceral arch, and to the peculiar character of the gill-clefts, filaments, and arches.

Is it possible that the teleosteans descended from a proto-amphibian stock more amphibian than the Dipnoi, that they owe their position of prestige to having served an apprenticeship in a less regular and constant environment, that a mutation led to a return to strictly aquatic habits? With questions such as these, Mr. Assheton relieves his statement of the facts of the development of Gymnarchus.

Mr. Assheton also reports on sundry teleostean eggs and larvæ which Mr. Budgett collected in the Gambia, and Dr. E. J. Bles contributes descriptions of some stages in the development of three Anura—*Paludicola fuscomaculata, Hemisus marmoratum,* and *Phyllomedusa hypochondrialis.* The last paper reminds us of what will strike everyone who looks over this stately volume; we refer to the fine illustrations. Mr. Budgett was a skilful draughtsman, Mr. Assheton is equally gifted, and there is quite remarkable merit in the drawings by Mr. A. K. Maxwell.

One of Mr. Budgett's discoveries was a fresh-water medusa in the delta of the Niger. According to Mr. E. T. Browne this is referable to the species (*Limnocnida tanganicae*) that has been found in Lake Tanganyika, and its occurrence in these widely-separated localities becomes intelligible if we regard it as a relic of the fauna of the Lutetian Sea, which the geologists believe to have stretched across Africa in Middle Eocene times. Mr. Browne gives an interesting account of this remarkable type, which remains unclassifiable. There is probably a gymnoblastic hydroid stage awaiting discovery.

The volume is an eloquent tribute to the esteem in which Mr. Budgett was held by his friends, for besides the editorial labours and Mr. Shipley's beautifully executed sketch, the working-up of the embryological material—especially that which fell to Prof. Graham Kerr and Mr. Assheton—must have involved much time and thought. Those who have by their own masterly work thus completed Budgett's have certainly been generous in their friendship, and the memorial volume, which is a valuable contribution to embryology, will surely not fail of its highest purpose, of perpetuating by its stimulus the tradition which Budgett's life and work expressed.

## *HIGHER ALGEBRA AT HARVARD UNIVERSITY.*

*Introduction to Higher Algebra.* By Maxime Bôcher. Prepared for publication with the cooperation of E. P. R. Duval. Pp. xi+321. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1907.) Price 8s. net.

WITH the cooperation of a former pupil, Mr. E. P. R. Duval, Prof. Bôcher has made into a book part of the subject of his lectures during the last ten years. Of course, it would be unfair to try to reconstruct the lectures from the book, but we do get an impression from this volume, and especially from the preface, of the problems which a Harvard professor has to face, and how he deals with them. We are told that

"An American student approaching the higher parts of mathematics usually finds himself unfamiliar with most of the main facts of algebra, to say nothing of their proofs. Thus he has only a rudimentary knowledge of systems of linear equations, and he knows next to nothing about the subject of quadratic forms."

For a student of this kind Prof. Bôcher provides a book which contains the elementary theory of polynomials, determinants, systems of linear equations, matrices, invariants, and symmetric functions, besides a discussion of quadratic forms which goes into considerable detail, and is based on the work of Smith, Sylvester, Weierstrass, and Kronecker.

The author makes special mention of Kronecker and Frobenius, and, in fact, it is easy to see how these great analysts have influenced the writer both in his choice of topics and mode of treatment. Whatever may be thought about the subjects discussed, there is no doubt about the soundness and thoroughness of the treatment; and it would be very interesting to know what is the effect of a course of this kind upon a class of American students, and what would be the result of giving it to an English class of a similar grade. It ought at least to arouse interest, and would probably induce the best students to read some first-rate memoirs, and possibly produce something of their own—though it must be confessed that the theory of quadratic forms, which is the *terminus ad quem* of this book, has been so thoroughly worked out now that there does not seem much chance of developing it further.

It should be stated that Prof. Bôcher by no means confines himself to abstract analysis; on the contrary, like Klein, he takes every opportunity of giving geometrical interpretations, and although he does not say so, it is likely enough that he has illustrated by diagrams and models the different ways in which two proper or degenerate quadric surfaces may intersect. Some of his groups of examples are calculated to suggest methodical lines of research in other directions; for example, on pp. 260–61 we have an outline of the theory of the binary quartic.

Generally speaking, the style of the book is very clear and simple. One exception occurs on p. 120, theorem 2, where it is not sufficiently emphasised that in the first case $\Sigma a_{ij} x_i y_j = 0$ is to be made an identity in the $x$'s by giving suitable fixed values to the $y$'s. And although the notion of a domain of rationality is explained (pp. 175, 212, 216), it would have been better to do this at an earlier stage.

The printing, done at the Norwood Press, is very good on the whole, but the suffixes are often unpleasant to look at, owing to want of gradation in type. On the other hand, we do find $x_2^2$ printed nearly as it is written—a very rare experience in English-printed books. It would serve a useful purpose if a congress could be held between mathematicians and mathematical printers and compositors; the former often forget that what is easy to write may be difficult to print, and the latter are very conservative, besides failing to sympathise with a mathematician's way of writing formulæ, especially in matters of proportion and spacing.

G. B. M.

## *METEOROLOGICAL OBSERVATIONS.*

*The Observer's Handbook, Meteorological Office,* 1908. A new and revised edition of Dr. R. H. Scott's "Instructions in the use of Meteorological Instruments." (London: H.M. Stationery Office.)

THIS book consists of two parts, and appendices. Part i. follows somewhat in the line of Dr. Scott's handbook, but part ii. is practically new, and deals with recording instruments, several of which have come into use since the previous book was published.

The issuing of a new official guide for its observers by the Meteorological Office gives an opportunity of comparing the state of the science of meteorology now and twenty years ago, in so far as instruments and observations are concerned, and in two respects the book shows considerable advance. Thus twelve pages are devoted to the Campbell Stokes sunshine recorder, and full instructions for setting the cards and adjusting the instrument are given, although the measurement of sunshine is not mentioned in the old book. Also the doubt about the measurements of wind velocity by the Robinson anemometer and the relation between the recorded velocity and the numbers of the Beaufort scale has been to a great extent removed. A useful classification of the scale, and a description of the results produced both on sea and land by the winds denoted by the various numbers, are given. Notwithstanding this, a man must be more than human if his estimation is entirely free from the influence of the prevailing conditions to which he has recently been exposed. A scale of fog intensity based on the inquiry supported by the London County Council in the winter of 1902–3 is also given.

Feinman's nephoscope and Besson's comb nephoscope are described. Probably the authors are not to blame, but it is a pity that cloud velocities are not measured in angular velocities, or rather angular velocities reduced to the zenith, the tangential velocity of the handbook. Certainly angular velocity is the only physical quantity in which cloud motion as seen from a single station can be expressed. It seems absurd, and is certainly very far from the truth, to assume that all clouds are at a height of 1000 metres, or that all clouds are moving with a linear velocity of 1 metre per second. Why, too, should the term "relative" be used? If relative means angular, as appears from the context, its use is incorrect, and although sanctioned by past usage, it would be well to give up the incorrect use of a technical word.

In the chapter dealing with the corrections to be applied to the barometer, it might have been well to point out that the reading in windy weather is to some extent dependent on the position of the room, and the way in which openings from it are situated with regard to the wind direction. There is plain evidence that an important error may be so produced.

The appendices consist of the usual tables and a memorandum by Dr. Shaw on the important question of units. In it Dr. Shaw points out the objections to both the systems now in use. To avoid the trouble of negative temperatures he advocates the use of the absolute centigrade scale, omitting the first figure, which will almost always be 2. This would be a vast improvement, and would earn the gratitude of all who have to obtain mean temperature values for places in temperate latitudes. In addition to the question of negative values, the muddle of having two systems is most pronounced in the case of temperature, for the alternative values cannot be read off from a slide-rule, as they may be for the barometer and the rainfall. An entirely fresh system has perhaps a better chance of general adoption than either of those now in use.

The handbook is carefully prepared, and contains much interesting matter, and Mr. Lempfert is certainly to be congratulated on its publication.

## *SOME PHYSICAL TEXT-BOOKS AND LECTURES.*

(1) *Theorie der Elektrizität.* Vol. i., Einführung in die Maxwellsche Theorie der Elektrizität. By Dr. A. Föppl. Third edition, edited by Dr. M. Abraham. Pp. xviii+460; illustrated. (Leipzig: B. G. Teubner, 1907.) Price 12 marks.

(2) *Kleiner Leitfaden der praktischen Physik.* By Dr. F. Kohlrausch. Second enlarged edition. Pp. xviii+268; illustrated. (Leipzig and Berlin: B. G. Teubner, 1907.) Price 4 marks.

(3) *Die Stimmgabel: ihre Schwingungsgesetze und Anwendungen in der Physik.* By Dr. E. A. Kielhauser. Pp. viii+188; illustrated. (Leipzig: B. G. Teubner, 1907.) Price 6 marks.

(4) *Luft, Wasser, Licht und Wärme.* By Dr. R. Blochmann. Third edition. Pp. vi+149; illustrated. (Leipzig: B. G. Teubner, 1907.) Price 1.25 marks.

(5) *Moleküle, Atome, Weltäther.* By Dr. G. Mie. Second edition. Pp. iv+142; illustrated. (Leipzig: B. G. Teubner, 1907.) Price 1.25 marks.

(6) *Die Stellung der Physik zu den Naturwissenschaften und der Technik.* By Aug. Hagenbach. Pp. 25. (Leipzig: B. G. Teubner, 1907.) Price 0·80 mark.

(1) OF this group of volumes the first is undoubtedly the most important. Since, however, it is the third edition which is before us, and very few changes have been made, it calls only for a short notice. These changes consist of alterations in the arrangement of the matter and a revision of the text here and there wherever it was found possible to make the exposition clearer. These changes have been made under the editorship of Dr. M. Abraham. The result is to improve a book of exceptionally high standing. We do not hesitate to affirm that we have in it one of the best expositions of Maxwellian doctrine, and at the same time one of the best introductions to vector analysis.

(2) This also is an improved edition (the second). For a "smaller" text-book it contains an enormous amount of information useful for general reference. This information is necessarily very condensed. In some cases it will probably be found insufficient by anyone except an expert experimentalist; that is to say, by one (for example, a chemist) who, though proficient in laboratory work, is not acquainted specially with practical physics, and wishes for hints in regard to physical processes.

(3) A monograph on the tuning-fork and its applications is a very welcome addition to physical literature. This one is based upon about eighty original papers published mainly since 1870; these lie within the period during which most work on this instrument has been done. When it is stated that the volume is non-mathematical, it will be obvious that it does not by any means profess to be complete; it will also be understood how it is that there are only two references to Lord Rayleigh in it, and that his "Theory of Sound" is not quoted in the list of consulted books at the end. This limitation in the treatment excludes many of the most interesting problems in connection

with this subject. But there is a great deal of valuable matter gathered here bearing on its properties, and it may very usefully be consulted.

(4) The somewhat inclusive title of the fourth volume under review covers a course of lectures on elementary physics and chemistry. Few alterations have been made from the earlier editions. A lecture has been added on liquid air. The book has found many friends, as we might have expected, and we have no doubt it will find many more.

(5) In this second edition of Dr. Mie's book a short section on radio-active bodies has been added. When it is stated that this occupies part only of a single page, it will be clear that it is not a detailed account. It is concerned only with the question of the composite nature of an atom and the transmutation of the elements. A few emendations have been made in the text to increase the lucidity.

(6) A short lecture on the relation of physics to other sciences, in the light of modern work on physical chemistry and recent discoveries of the non-valent gases and of radio-activity. While admitting the necessity of specialisation, it is urged that a broad outlook should be encouraged.

## OUR BOOK SHELF.

*Refrigeration: an Elementary Text-book.* By J. Wemyss Anderson. Pp. ix+242. (London: Longmans, Green and Co., 1908.) Price 7s. 6d. net.

THE increasing use of refrigerating processes in the distribution and preservation of food, and also in many important industries, has already called for a special type of engineer who must possess a knowledge, not only of machines and mechanism, but also of the theoretical properties of heat. Nowadays, when the market for electrical engineers is becoming uncomfortably crowded, young men would do well to consider the prospects open to them as refrigerating engineers. To those who wish to enter this profession Mr. Anderson's book will be most welcome as an introduction to the fundamental principles on which modern refrigerating processes depend.

The treatment of the subject is accurate and lucid, and in all cases the necessary mathematical investigations are reduced to their simplest elements, many numerical examples being added. The first three chapters are devoted to a brief *résumé* of the elementary properties of heat, including radiation, conduction, and convection. In chapters iv. and v. the elastic and thermal properties of fluids are dealt with. A simple explanation of the first and second laws of thermodynamics is given in chapter vi. The remaining six chapters are of a more practical character, special attention being paid to the solution of problems which arise in connection with refrigerating processes. Cold-air machines, vapour machines, compression machines and absorption plants are described in chapter vii. The liquefaction of air is considered in chapter viii., and ice-making in chapter ix.

A very important branch of the subject is dealt with in chapter x., where the methods of insulating and cooling large chambers are described and illustrated. Miscellaneous uses of refrigeration are considered in chapters xi. and xii.; in order to appreciate the extent to which refrigerating processes are used industrially, it is only necessary to glance through the contents of these chapters. Ice-making is in demand for general purposes, and for skating rinks and curling ponds. General cooling is used for keeping meat and other food-stuffs, and for increasing the yield of butter from milk. Special cooling arrangements are required for keeping ammunition (such as cordite) in a proper condition. The growth of plants and shrubs is checked, and unripe fruit is kept so that it can ripen according to the market, by the aid of suitable methods of cooling.

In general engineering, refrigerating processes are used for drying the air supplied to blast furnaces, and for hardening sandy or boggy soils in order that tunnels may be made or shafts sunk. Cooling processes are also largely used in the brewing industry. Mr. Anderson does not profess to treat of these applications of refrigeration in detail, and the design of refrigerating machines is not dealt with; but the student commencing the study of the subject cannot do better than master the contents of Mr. Anderson's book, after which he will be in a position to understand the nature of the problems which confront a refrigerating engineer, and upon the solution of which his success will depend.

E. EDSER.

*Ceylon. A Handbook for the Resident and the Traveller.* By Dr. J. C. Willis, Colombo Apothecaries' Company. Pp. x+247+iv. (London: Dulau and Co., 1907.) Price 5s. net.

THE Director of the Royal Botanic Gardens of Ceylon explains that he is the author of this handbook by default. He was of opinion that a handbook was needed, and having failed to persuade one better qualified than himself to become the author, Dr. Willis undertook to write the book himself. He gravely informs us in the preface that the idea was to write a comprehensive work of about 1000 pages, and that having devoted eight months of his leisure to writing the agricultural section he found that this alone would take 125 pages of the present book in print, whilst on the same scale the entire volume would take him ten years to complete. The chapter on agriculture was therefore reserved as the basis of a separate volume on tropical agriculture, and the present book of 244 pages was written with the assistance of many friends and authorities in the island.

The book includes a brief account of the natural features of Ceylon, of its history and peoples, with descriptions of roads, railways, towns and villages, and of the principal industries, with chapters on sports and games. It contains two small sketch-maps of Ceylon, and is illustrated with numerous photographs, many of which are excellent. As a whole the book is disappointing. It can, of course, lay no claim to comparison with Emerson Tennent's famous work, and the author's style is crude and has none of the charm of Sir Samuel Baker's. A great deal of information, solid and trivial, is conveyed in a terse but loose grammatical style of which the following sentences are examples:—"The Museum is closed for cleaning on Fridays and admission is always free." "Water is usually pretty bad in the low country and should always be filtered before use, though if used for tea-making unfiltered the boiling will have about killed all germs."

"The native who has lost his taste for his own art is in regard to whatever style of art he adopts among the most inartistic people on the face of the earth, as one glance into any native house furnished in European style will show. Many are in the worst style of early Victorian, whereas a native house furnished in the old native manner is a pleasing sight."

As the work of a man of science the book is distinctly disappointing, and is little, if any, improvement on the Ceylon handbook to the St. Louis Exhibition, on which the author has largely drawn. The section on agriculture is one of the best in the book, but even here there are many signs of the effort which has been exerted in writing short popular descriptions.

It is to be feared that the book will fall between two stools. It is too dry and unattractive for the ordinary traveller, whilst the serious student will not find it satisfactory.

Dr. Willis would have been better advised had he devoted himself to preparing a more serious work, or, if time did not permit of this, to producing a new edition of Sir Emerson Tennent's standard treatise. The present work is not likely to add to his reputation.

*The Royal Gardens, Kew.* From photographs taken by permission. By E. J. Wallis, with descriptive notes by H. Spooner. Pp. 64. (London: E. J. Wallis, 42 Gloucester Road, Kew Gardens, n.d.) Price 1*s*. net.

It is difficult to realise that the modern development of Kew Gardens as a public institution only dates back to the middle of the last century, when Sir William Hooker initiated the extensions and improvements that have been continued by his successors in office. Increased travelling facilities in recent years have largely augmented the number of visitors to Kew, and consequently there is certain to be a large demand for a popular account of the gardens that will serve as a memento of what must often be memorable visits. The illustrations provided by Mr. Wallis depict exteriors and general views, selected spots in various houses, and a few specimen plants. The photographs of the tropical water-lilies and of the Yulan, *Magnolia conspicua*, are especially pleasing, also of the delicate flowers *Cypripedium glaucophyllum* and *Peristeria elata*. Mr. H. Spooner has contributed the text, in which strangers will find a useful guide round the houses and to the choice specimens, as well as brief descriptions of the more regular and conspicuous tenants.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

### The Ciliated "Urns" of the Sipunculids.

In the winter of 1871–2 I studied the richly corpusculated perivisceral fluid of *Sipunculus nudus* at Naples. I was with Anton Dohrn, who was making arrangements for the building of his celebrated laboratory. That remarkable marine zoologist Krohn, who in 1851 had described the ciliated "urns" (Töpfchen) of the body-fluid of Sipunculus as parasites, was there, and spent an evening with us. I described the ciliated urns briefly in the *Annals and Mag. of Nat. Hist.*, vol. xi. (fourth series), 1873, p. 89, and pointed out their mode of origin. I say, "Further, I have found out the source of the 'Töpfchen.' They are to be observed in great numbers *attached within* the curious pair of tubes or vessels formed by duplicatures of the peritoneal membrane, which lie on each side of the œsophagus." I then give a wood-cut figure of the attached "urns" with long stalks, and state that "they develop as buttons on the cellular surface," and that "they become detached and swim off into the fluid."

This statement was erroneously quoted nearly thirty years after its publication, in the first instance by Cuenot, who said that I stated that the urns were developed on the outside of the œsophageal tubes, whereas I had italicised my statement as above to the effect that they are developed on the *inside* of those tubes.

The matter is not one of great importance, but it is not agreeable to see a statement repeated to the effect that one said just the opposite of what one did say. This repetition of an error is made by Dr. Selensky, of St. Petersburg, in the *Zeitschr. f. wiss. Zoologie*, Bd. xc., p. 558. He apparently has not consulted my paper, but, although he does not say so, has taken his information from Cuenot, to whom, erroneously, he attributes the first correct observation as to the place and mode of origin of the ciliated urns of the Sipunculids, an observation published by me now thirty-five years ago. I wish clearly to state that I am quite sure that neither Prof. Cuenot nor Dr. Selensky had any notion that they were not quoting me correctly. I should have let the matter pass altogether had there not been lately an attempt to revive the notion that these curious freely swimming corpuscles with their crown of cilia are parasites. I disposed of that hypothesis when I observed in 1871–2, and figured in 1873, their mode of growth.

E. Ray Lankester.

29 Thurloe Place, S.W., July 30.

### Prominence and Coronal Structure.

Communications by Dr. Lockyer and by Mr. Buss have appeared in recent numbers of Nature (April 2, June 18, and June 25) under the above heading. In the last-mentioned number Dr. Lockyer quotes a portion of a letter which I wrote to him following the publication of his original paper, showing the triple-arch prominence. I examined my plates under very unfavourable illumination, and wrote that no prominence of unusual form was discernible in the position which he gave. More careful examination shows a faint, detached, V-shaped cloud attaining an elevation of 67,000 miles, as probably the last remnant of the prominence, at considerable elevation. The accompanying figure will show this faint cloud at 146°·5.

I regret that Dr. Lockyer did not quote my letter further, for I wrote that I had so often seen a prominence, risen to considerable height, topple back into the sun, thus making an arch, that it seemed unwarrantable to assume another explanation for their formation without positive knowledge that the earlier stages of development were contrary to this usual performance. Fortunately, Mr. Buss had earlier observations of this prominence, and these showed the arches to have had the usual origin.


Concerning the prominence in the south-western quadrant, Fig. 2 of Dr. Lockyer's letter, for which he suggests the possibility of false orientation on my print, the present figure shows that the orientation was correct. The part of the prominence corresponding to the prominence at 218° shown on the negatives of Dr. Lockyer and of Prof. Hale is easily recognised at 219°·3. The long arm springing for position-angle 208° is apparently a new development.

Philip Fox.

Yerkes Observatory, July 18.

### Fossil Aphididæ from Florissant, Colorado.

The plant-lice of the Miocene shales at Florissant, Colorado, have been described at length by Scudder in his great work on Tertiary insects (1890). He was able to recognise no fewer than fifteen genera and thirty species. All the genera were considered to be extinct, and although they included both Aphidinæ and Schizoneurinæ, they were found to differ from the modern representatives of these subfamilies in an important character running throughout the series—the length and slenderness of the marginal or stigmatic cell. In this they also differ from the European Tertiary Aphididæ, although, according to Scudder, they resemble a species (*Genaphis valdensis*, Brodie) from the Jurassic of England. This Genaphis, however, has a short thick stigma, such as may be seen in some modern Chaitophorus, whereas the stigma in the Florissant forms is long and slender.

There are two ways in which the peculiarities of the Florissant Aphididæ might be explained. Either it might be supposed that they have undergone parallel evolution in a certain direction, giving rise to the present fauna, or it might be held that they represent an extinct series, driven out of existence by the Aphididæ of the Palæarctic fauna, which reached America in the late Miocene or early Pliocene. Supposing the original centre of Aphid evolution to have been Palæarctic (perhaps Asiatic), it may be that in late Secondary or early Tertiary times Aphididæ reached America, giving rise in due course to a series of genera, a good sample of which is preserved for us at Florissant. This would readily explain the peculiar fact of certain characters running throughout the series, these being derived from the original immigrants. While this evolution was proceeding, the old-world Aphides were undergoing developments of their own, leading directly to the present Aphid fauna of the north temperate regions. The generic uniformity (with few exceptions) of this fauna points strongly to its common source, and the European Tertiary Aphid fauna appears to corroborate the idea that this was Palæarctic. It remains only to suppose that when the Palæarctic Aphides reached America they were successful in ousting the endemic genera, which would have been totally lost to science had they not been preserved at Florissant. Perhaps, however, they have not been so completely lost, and it may be that aphidologists, with the palæontological facts in mind, will even yet discover some of the Florissant genera living in the mountains of Central or South America.

In this connection it may be well to direct attention to the very important paper by Dr. W. D. Matthew, lately published in the Bulletin of the American Museum of Natural History, June 30. In this paper Dr. Matthew discusses the evolution of the deer (Cervidæ), and concludes that these animals have successively dispersed from a local centre, driven southward before the competition of higher types evolved in the centre of dispersion. "These migrant types continue to evolve in certain respects, such as brain-capacity, which are advantageous in any habitat, but preserve most of their primitive characters as the environmental pressure is less in amount and more variable in direction." These are not mere suppositions; actual evidence is produced to show that the oldest genera are to-day the most southern, and it is suggested that had the connection between north and South America existed earlier, we might expect to find still more primitive forms in the southern continent. This *law of successive radiation*, as it might be termed, will undoubtedly throw new light on many problems of distribution and evolution. So far as it is found to be true, it will teach us that we must be cautious in thinking of the present home of the more primitive types of a group as the original centre of that group; that the occurrence of similar forms in two southern lands does not necessarily imply a former transoceanic southern bridge; or that the existence of a type in a particular region necessarily implies any *special* fitness to live in that physical environment.

As Dr. Matthew states, much has been written on the geographical distribution of modern animals from the general standpoint which he advocates,[1] but not enough has been done to interpret the palæontological facts in connection with the modern. Our daily increasing knowledge of the Tertiary fauna and flora promises much in this respect, and it is interestingly significant that independent studies of deer and plant-lice should lead to similar conclusions.

The Florissant Miocene Aphididæ are given above as numbering thirty. I have before me an additional one, the largest of any yet found. It is a species of Anconatus, differing from *A. dorsuosus*, Buckton, by the wholly pallid (pale ochreous) abdomen, and the anterior wing about 9 mm. long. The legs are remarkably large, the middle tibiæ, for instance, about $3\frac{1}{2}$ mm. long. This insect, found this year at Station 13 B, may be termed *Anconatus gillettei*, in recognition of Prof. C. P. Gillette's important researches on Colorado plant-lice. Detailed measurements will be given elsewhere.

If it is asked how the Palæarctic Aphids could possibly have routed the Nearctic ones, as suggested, the answer may be found in the supposition that the former brought with them certain parasites or diseases, to which they had become relatively tolerant, but which worked havoc among the American species, just as some European diseases of man have done in recent times when carried to American tribes.

T. D. A. Cockerell.

University of Colorado, Boulder, Colorado, July 21.

[1] See, for instance, J. W. Taylor, "Monograph of the Land and Freshwater Mollusca of British Islands," vol. i., pp. 389–90 (1900.)

## THE NATURAL HISTORY MUSEUM.

As was recorded in last week's Nature, on Tuesday, July 28, a deputation, which included Mr. F. Darwin (Cambridge), Prof. Cossar Ewart (Edinburgh), Prof. Sedgwick (Cambridge), Dr. Marr (Cambridge), Prof. Hickson (Manchester), Prof. Bourne (Oxford), and Prof. Graham Kerr (Glasgow), waited on the Prime Minister (The Rt. Hon. H. H. Asquith, K.C., M.P.) in support of a petition sent to the late Prime Minister last autumn requesting that advantage should be taken of the present vacancy in the directorship of the Natural History Museum to hold an inquiry into the methods by which the museum is governed. The deputation was introduced by Sir W. Anson, M.P., Mr. Rawlinson, M.P., and Sir H. Craik, M.P.

From the statements made by the members of the deputation it appears that the Natural History Museum is administered by the trustees of the British Museum, and that their principal librarian is responsible for the Natural History Museum at South Kensington as well as for the library and art collections at Bloomsbury. For half a century naturalists have been directing attention to the necessity for some change being made in the administration of the natural history department of the British Museum. In 1858 Mr. Darwin wrote to Sir Joseph Hooker that he could see many advantages in withdrawing natural science from the "unmotherly wing of art and archæology," but he thought that the "contempt for, and ignorance of, natural science" was so profound "among the gentry of England" that the time had not come when science could stand alone.

Some years later (1866), the situation appearing more favourable, the most distinguished men of science of the day (amongst others Darwin, Hooker, Huxley, Newton, and Wallace), in a memorial to the Government, expressed the opinion that "it is of fundamental importance to the progress of the natural sciences in this country that the administration of the national natural history collections should be separated from that of the library and art collections."

In 1874 a Royal Commission on "Scientific Instruction and the Advancement of Science" directed attention to the statements of witnesses that it was "unsatisfactory that the national collections should be managed by a body of gentlemen whose time is in most cases fully occupied by other important duties, and the majority of them are not selected with reference to any special qualifications for such a post." These commissioners, in their fourth report, recommended "that the occasion of the removal of the natural history collection to South Kensington". . . "should be taken advantage of to effect the desired change, and that on their new site the collections should be removed from the control of the trustees of the British Museum." As this commission was a strong and representative one—it included, amongst others, the Duke of Devonshire, Sir John Lubbock, Dr. Sharpey, Mr. Huxley, and Sir George Stokes—it was anticipated by naturalists that the Government would give effect to its recommendation. In this they were mistaken, for in the Bill passed in 1878 giving the trustees power to remove the natural history collections to South Kensington, no provision was made for a change in the administration of the Natural History Museum.

The recommendation of the Royal Commission having been ignored, the British Association for the Advancement of Science in August, 1878, urged the Government to reconsider the matter, but nothing was done.

After a lapse of ten years a representative body of scientific men, including Lord Kelvin, Sir G. Stokes, Sir M. Foster, Sir A. Rücker, Sir John Murray, Dr. Francis Galton, Sir Henry Thompson, Sir W. Turner, Sir Benjamin Baker, and Mr. A. R. Wallace, presented a memorial to the trustees in which it was stated that in their opinion it was "of great importance to the welfare of natural history that the principal official in charge of the national collections relating to this subject should not be subordinate in authority to any officer in the museum."

It may here be mentioned that a concession of some importance was made by the trustees in 1885. On the recommendation of the late principal librarian, Sir E. Bond, the office of superintendent of the natural history collections was in 1885 replaced by a new office, that of director, with new duties, new responsibilities, and new salary. But the concessions made in 1885 which gave the director of the Natural History Museum a position of comparative independence were deliberately revoked in 1898.

It seems that, though it is generally assumed that the trustees as a whole administer the Natural History Museum and are responsible for the expenditure of the very considerable sum (56,000*l.*) annually voted by Parliament, the museum is actually controlled by a standing committee, while the director, inferior officers, and assistants down to servants are appointed by the three principal trustees. As there are forty-nine trustees, the board cannot act effectively as a single body, and, as the 1874 commissioners state, it is "singularly inappropriate that the three important personages who are the principal trustees, occupied as they are in the discharge of the highest functions in Church and State, should be burdened with the duty of making appointments to offices of every grade in the British Museum."

Prof. Sedgwick, in referring to the memorial presented last August to the late Prime Minister, said that zoologists thought it desirable to at once call the attention of the Government to the desirability of instituting an inquiry into the methods of administration of the Natural History Museum, and that, if necessary, a widely signed memorial could be sent later on. In concluding a very full statement, Prof. Sedgwick said:—

"We are here to ask for a full official inquiry into the organisation and administration of the Natural History Museum with a view to a reasonable treatment of the matter in the immediate future by His Majesty's Government."

Mr. Francis Darwin especially referred to the subordination of Cromwell Road to Bloomsbury. He said:—

"Quite apart from the welfare of the Natural History Museum, it seems unfair to expect of the principal librarian that he should be responsible for Cromwell Road in addition to his other heavy responsibilities. Nor can it be to the advantage of the British Museum that its principal officer should be so occupied. But it is when we look at the other side of the question that the faultiness of the arrangement becomes fully obvious. To choose a man distinguished for his technical knowledge and then to fail to give him reasonable freedom in the employment of his training and experience seems as bad a plan as it is possible to conceive.' . . . 'I believe I am right in saying that when the late director was appointed his freedom was curtailed. It was, I think, unavoidable that in these circumstances difficulties should arise, and I feel very strongly that we ought to make the recurrence of such difficulties impossible; and this can only be done with certainty by making the Natural History Museum an independent unit.'"

This view was supported by Prof. Bourne, who stated that

"the Natural History Museum will not be placed upon a satisfactory footing until it is placed under the control of a body of trustees separate from that which is responsible for the control of the British Museum at Bloomsbury."

Prof. Hickson pointed out that, notwithstanding the representations made by men of science during recent years,

"no changes or reforms had been effected, and the administration is practically the same now as it was before the collections were removed from Bloomsbury," and that for seven months "the museum has been deprived of the services of both a scientific director and a keeper of zoology."

Prof. Ewart directed attention to the present unsatisfactory method of appointment of the director and of the subordinate members of the staff of the Natural History Museum; Prof. Kerr said that, owing to the dissatisfaction which exists amongst men of science, it is "essential to hold a careful inquiry into the whole question of the organisation and administration of the Natural History Museum before coming to a decision as to the remedial measures to be adopted," and Dr. Marr directed attention to the inadequate representation in the museum of those important branches of geology which are distinct from botany and zoology.

The Prime Minister, according to an official report which has been supplied, replied as follows:—

He expressed his profound satisfaction at meeting so many eminent men of science. He pointed out that, as regards the administration of the museum, the trustees are a statutory body with whom the Government were powerless to interfere. He confessed himself still unable to grasp in what way the museum failed to perform its functions. The arguments advanced by so many of the deputation as to the management by the trustees applied equally to the Bloomsbury museum. The trustees, men of wide experience and great distinction, were equally cognisant of natural history and archæology. He announced that the trustees were about to appoint a keeper of zoology, and that it was not intended to abolish the directorship, but only to wait to ascertain who was the best man for this responsible position. He sympathised with the view that the director should have a free hand in the management of his department, and promised to convey to his fellow-trustees of the British Museum all that the deputation had suggested.

In reply to the Prime Minister's remarks, it may be pointed out that, had the Natural History Museum come into existence during the later half of last century it would doubtless, like the American Museum of Natural History and other recently established museums, have been placed under a separate board of trustees. But for the want of an appreciation of science in England, the request for an independent position for the Natural History Museum by men of science would have been almost certainly granted when the natural history collections were removed from Bloomsbury to South Kensington.

## *BIRDS, BEASTS, AND FISHES OF NORTH WALES.*[1]

DESPITE its unrivalled scenic attractions and its popularity as a health resort, North Wales has until recently received scant attention from zoologists, references to the district in standard works on British vertebrates being comparatively few, and often erroneous. The need of a comprehensive local fauna dealing with the district has long been felt. But it was recognised that there was no one man who was able to do the work. It could only be accomplished by the cooperation of a large number of naturalists resident in Wales and non-resident. For although comparatively little has been written about the vertebrate fauna of North Wales (and a good deal of that little quite recently), a good many observers, both residents and visitors, have been working steadily at it for some years. It remained to collect, sift, and arrange the facts they had got together. Mr. Forrest came forward and undertook this arduous work, and he obtained the practical assistance of a number of naturalists (a list of whom appears in the book), who readily placed their stores of information at his disposal. He has also examined what little literature (dating some way back) there was on the subject. This information he was able to supplement from his own observations, made during many short visits to the Principality. The result has been an excellent handbook to the vertebrate fauna of North Wales.

The introduction comprises some account of the former zoologists of North Wales, with portraits; a bibliography; a short account of the physical features of the country; some account of bird migration, wherein the routes are carefully traced, not an easy matter in a mountainous country; and a note on the Welsh names. Two conclusions reluctantly force themselves upon us after a perusal of this work. One is that North Wales is not a natural faunal district. West and east differ too greatly. Speaking of the rugged mass of mountains which stretches almost uninterruptedly from the Menai Straits to the Dovey estuary, the author himself says that the importance of this mountain barrier in limiting the distribution of species can hardly be over-estimated. In a very large number of instances, species are confined to the eastern side of this barrier. The truth of this is particularly evident in regard to many woodland birds and fresh-water fishes. The second conclusion is that the vertebrate fauna of a district like this (which, although its actual area is small, is so diversified in its physical aspect) is too big a subject for one octavo volume, bulky almost to clumsiness as this volume is.

The work shows signs of being cramped, and there is evidence that the vast amount of information at the author's disposal has been unduly condensed, and that the material has lost in the process. This is not of too great importance, or wholly a drawback. For it is distinctly an advantage to have a fauna containing all the main facts in one volume, and, despite its fatness, we may call it a handbook to the vertebrate fauna of North Wales, if it is not a history of it; and the way is still left open to anyone who may be able and willing to write a "Birds" of any of the North Welsh counties. How fascinating such a book, dealing fully with the bird-life, would be only those

*Photo*] Puffins on St. Tudwal's. From "The Vertebrate Fauna of North Wales." [*H. E. Forrest.*

who know Wales in the spring and early summer can tell. But even in the present work we should have been glad of more details. The life-histories as observed in North Wales could have been fuller with advantage. We do not notice that the habit of the merlin of breeding on the sea coast in other districts besides Anglesey is alluded to, or the fact of the overflow population of great jackdaw haunts nesting in crowds in rabbit burrows on a hillside; and many other points might have been touched upon. More exact details of the *local* nests of the buzzard built in trees would have been welcome. Nor is the distribution of birds in the breeding season so exact and full (safeguarding rare birds being understood) as might be. More details of the position of breeding stations of rock birds might have been given; and in the introduction a few pages might well have been devoted to a description of some of the more notable sea-bird stations.

This fauna is to a great extent pioneer work, and

[1] "The Vertebrate Fauna of North Wales." By H. E. Forrest. Pp. lxxiv+537; with 28 plates and a map. (London: Witherby and Co., 1907.) Price 17*s.* 6*d.* net.

the author points out that there is a great deal of work still to be done, especially among the reptiles and the marine fishes. There are blanks, too, in the general record that it has been impossible to fill owing to the lack of resident observers. The records from Snowdonia and the central moorlands, for example, are derived almost entirely from the observations of naturalists who have visited those districts from time to time, and there are few or no winter records from these districts. The author proposes to publish additional records in the form of a supplement. We might suggest instead of this a new edition in two or more volumes, with more space and greater detail and the *authority* for the statements, which should always be given in a compilation.

Mr. Forrest has carried out a difficult and laborious task so well that we feel he might well undertake a work which would be monumental as a history of the vertebrate fauna of the most interesting (from that point of view) part of these islands. It was not to be expected that many of the rare stray avian visitors which straggle to our shores would penetrate so far as Wales. Nor are its shores patrolled day after day, in season and out, by men with guns on the look-out for a rarity, as are parts of our east and south coast. Two hundred and seventy-two species of birds are enumerated. But it is in its breeding species that the richness of the North Wales avifauna consists. The author states that 143 species have been known to breed in the district. They do not all do so now; but it has a list of 126 annual breeders, although its total area is not much more than half that of Yorkshire, which, despite great diversity of physical features, can only claim three less.

Treating of the Welsh names, which are dealt with very fully, the author states that his aim has been to include only those which are actually used by the people of the district; "'book' names are excluded." We cannot, however, regard some of the names given as other than book names. The honey buzzard, for instance, seems far too rare to have a genuine Welsh name; the same may perhaps be urged in the case of the black-tailed godwit, and there seems no reason why it should be called "black plover." Again, if the Welsh locally distinguished the Arctic from the common tern at all, there seems no reason why they should have pitched upon a word meaning Arctic or northern unless they had been influenced by books. Nor can we agree with the author (while giving full weight to his authorities) in rendering barcud as kite. Bergut or bearcoot is the name for an eagle among the Kirgiz Tartars, and the buzzard is really an eagle, while the kite is not. Moreover, we have, according to Eugene Rolland, barged and barguet for the buzzard in Breton and Breton Armoricaine, but no name like it for the kite in those branches of the Celtic language. The bird of which Giraldus Cambrensis and his companions heard the sweet notes between Carnarvon and Bangor was not in all probability a golden oriole. Giraldus says "of a bird, which some said was a woodpecker, and others, more correctly, an aureolus." He was not the last to mistake a green woodpecker for an oriole. The misprints are so few that there is no sheet of *errata et corrigenda*. Had there been, perhaps the unfortunate blunder about the buzzard would not have gone uncorrected. The statements that it rears two broods in the year, and will lay again if robbed of its first clutch of eggs, are, of course, the opposite of the facts. A map of so diversified a district is doubtless a serious and troublesome matter, but the one given in this volume is on so small a scale, and the names are printed in so small a type, that it is almost useless to eyes that read ordinary small print without difficulty.

## *THE WATER PROBLEM IN AGRICULTURE.*[1]

The increasing use of artificial manures and of improved tillage implements has rendered possible an increase in the amount of produce obtained from a given area of land, and attention has during the past few years been directed to another factor, the water supply, which at present limits crop production in a number of cases. The amount of water actually transpired through the crop depends on too many circumstances to be stated with precision, but it may be roughly estimated at 300 lb. or more for every pound of dry matter produced, so that if two tons of dry matter is produced per acre, at least 600 tons of water, equal to 6 inches of rain, will be used in transpiration, quite apart from what is lost by evaporation, percolation, &c. A crop of this size is by no means excessive; indeed, in some types of intense cultivation three times as much produce would be aimed at. Even in England the problem is often serious; it is far more so in countries where the rainfall is deficient during the whole or part of the growing season.

In order that a large proportion of the rain-water should remain near the surface of the soil within reach of the plant roots, it is obviously necessary to reduce loss by percolation and evaporation. The practical man in dry districts has succeeded in evolving methods which go some way to doing this. The methods and implements used by the Madras cultivators are described by Mr. H. C. Sampson in the Agricultural Journal of India. In some districts recourse is had to deep ploughing with a heavy plough, followed by a lighter plough, and then when the crop is up the land is hoed. In other districts the plough is the only tillage implement. But in practically all cases the plan is to stir the surface of the soil after a rain, and to keep the top soil loose during the growth of the crop. The methods adopted in the arid regions of the United States are described in the Transvaal Agricultural Journal (April, 1908) by Mr. Macdonald, and in the Journal of Agriculture of South Australia (March, 1908) by Mr. Strawbridge, who was sent with the express purpose of reporting thereon. They include deep ploughing, followed by harrowing, so as to get the soil into a fine state; the harrowing is, as a rule, repeated after each rain. When the crop is up the surface soil is frequently stirred. It seems definitely established that when the top layer of soil is in a loose condition it retains water better than if it is compact, but the loose condition must be maintained by constant stirring.

The gain in water content may probably be ascribed to decreased evaporation, for water evaporates less freely from loose than from compact soil. The explanation usually given is that the movement of water in soils (apart from the gravitational flow) is a surface-tension effect akin to the rise of water in capillary tubes, and is therefore facilitated when the spaces bebetween the particles are diminished, and impeded when the spaces are kept large. Frequent stirring of the soil, which prevents it becoming compact, reduces the capillary movement of water to the surface, and consequently lessens the evaporation. This hypothesis explains a good deal, but unfortunately it has not been very fully developed; there is little doubt that if some physicist would take the matter up he could obtain results of great importance to agricultural science and practice.

[1] (1) The Agricultural Journal of India, vol. iii., part 1. (1908.)
(2) Memoirs of the Department of Agriculture in India, vol i, No. 6, "The Loss of Water from Soil during Dry Weather," by J. W. Leather.
(3) The Transvaal Agricultural Journal, April, 1908.
(4) The Journal of the Department of Agriculture of South Australia, March and May, 1908.

A number of measurements showing the amount of evaporation from the soil, or the amount of water left behind in different circumstances, have already been made, and Dr. Leather adds a further interesting series. Water determinations were made in samples taken to a depth of 7 feet from a plot of soil at Pusa during the dry season. The results are as follows:—

*Lbs. of water per Cubic Foot of Soil.*

| Depth | Sept. 19 | Oct. 20 | Nov. 30 | Jan. 8 | Feb. 15 | March 27 | May 6 | June 5 | June 15 |
|---|---|---|---|---|---|---|---|---|---|
| 0–1 foot | 18·97 | 15·78 | 14·21 | 12·15 | 12·10 | 14·18 | 10·83 | 13·87 | 10·41 |
| 1–2 feet | 20·96 | 19·27 | 17·95 | 18·17 | 18·79 | 19·62 | 16·39 | 15·40 | 15·38 |
| 2–3 ,, | 24·75 | 18·84 | 10·68 | 11·95 | 12·00 | 10·51 | 10·35 | 9·67 | 9·03 |
| 3–4 ,, | 25·95 | 17·51 | 18·35 | 13·54 | 11·27 | 9·27 | 6·55 | 6·63 | 6·36 |
| 4–5 ,, | 25·65 | 23·69 | 21·91 | 21·07 | 20·18 | 19·56 | 18·10 | 16·20 | 16·64 |
| 5–6 ,, | 26·42 | 25·60 | 24·50 | 24·00 | 23·54 | 22·45 | 20·82 | 19·45 | 18·99 |
| 6–7 ,, | 26·42 | 26·00 | 25·00 | 25·00 | 25·30 | 25·26 | 24·5 | 23·10 | 24·00 |
| Total ......... | 169·12 | 146·69 | 133·00 | 125·88 | 123·18 | 120·85 | 107·57 | 104·32 | 100·81 |
| Rainfall in inches since last determination......... | | 0·82 | nil | nil | 1·14 | 1·85 | 0·89 | 2·08 | |

The showers only seem to have affected the surface layer. It will be observed that there is a considerable break below the fourth foot; this is due to a change in the soil, which unfortunately was not uniform throughout the entire depth. Taken as a whole, the figures show that the rate of loss decreases as the depth increases, but the want of uniformity of the soil makes it impossible to get out any expression showing the rate of loss. Dr. Leather argues that water moves upwards from a limited depth only, and considers that none has come from the seventh foot, but he offers no evidence on this point. The results are equally well explained on the supposition that the upward movement takes place at all depths, since the amount of water present in a particular layer depends on the respective rates at which water is gained from below and lost to the upper layers. If these measurements could be repeated on a fairly uniform piece of soil the results would furnish very valuable data for a study of the movements of water in soil.

E. J. RUSSELL.

## LORD KELVIN.[1]

THESE notices of the life and work of Sir William Thomson, Lord Kelvin, are all true, and they are all quite different from one another. Prof. Larmor dwells upon the important mathematical theorems with which Lord Kelvin enriched natural philosophy, and he is almost indignant that mere inventions for the service of man should have occupied the best time in the life of the greatest of naturalists. It is a masterly essay, and will be of the greatest value to some future biographer or historian of science. As Stokes and Fitzgerald are dead, there is nobody now living who could have done the work so well as Larmor. Nobody ever could have done it better.

Prof. Gray's book gives a very straightforward and interesting account of Kelvin's work; he does not dwell so much upon that part which had the higher mathematical aspects; he writes as an old pupil, as one who was Kelvin's secretary, and as the present occupant of his professorial chair. Probably this book will give most satisfaction to the general reader, but the reader must be one who already knows something of what Kelvin did in electricity and magnetism, and elasticity and light and thermodynamics. It gives an interesting account of college life and Kelvin's relations with his assistants and students.

Prof. Ayrton's article, in spite of an obvious restraint, is intense with affection and enthusiasm for the memory of his master. He dwells on none of the great theorems which are of fundamental importance in all applications of mathematics, which indeed created many parts of natural philosophy; he only casually mentions the discoveries and inventions of his chief, for he assumes that they are all well known; he merely recalls his own experiences of forty years ago, and his story is alive with interest, with reminiscences of a thousand acts of kindness and words of sympathy from a man who never seemed to remember his greatness when he was talking to a student, for indeed he was always a fellow-student.

Prof. Thompson's lecture, delivered to the members of the Institution of Electrical Engineers, was perfect for its purpose. He touched on most of Kelvin's work, but in particular he recalled to the leaders in electrical engineering the history of their profession. That history may be said to begin with Faraday and with Thomson's papers when he was not yet twenty years of age, papers in which he recognised the inner meaning of Faraday's work. Until he died he never ceased to make electrical history, but the most wonderful time was the time of his youth, when he was developing the theories which were to educate Maxwell. The lecturer recalled the practical electrical engineering work of the man who, when he died, was president of the institution for the third time. This is not the place to speak of the many other tributes which have lately been written to Thomson's genius and ability. The real life of Lord Kelvin has yet to be written, and the biographer will take account of the notices now before us, as well as many others, and he will especially use that masterly essay by Fitzgerald which was prepared for the Kelvin jubilee.

To us, Prof. Larmor's notice is the most wonderful of these productions. Was there ever so long an obituary notice of a Fellow in the Proceedings of the Royal Society? And this notice is filled not only with an enumeration of the contributions of Kelvin to applied mathematics, with sufficient detail to keep the reader intensely interested, but also with ungrudging praise. To anyone who knows the severity of Prof. Larmor's criticism, the almost impossibly high standards which the modern Cato is in the habit of applying to all scientific work involving mathematics, this obituary notice will count as the greatest praise ever given to any scientific man! It is from another point of view that we would ask students to read particularly what Prof. Larmor says about the memoirs of Clausius of 1850 and Thomson's papers on thermodynamics until 1851 and on to 1855. It is just possible that the men who think they know the thermodynamic events of that most interesting time may find that Thomson's habits of self-effacement have made it necessary now to re-write the history. We know that it was all one to him; he never made a claim for priority except on behalf of somebody else than himself. We are sorry to say that we can make no more comments on these essays; when we try to write, memory throngs too much with reminiscences and power of expression fails us. He is still too close to us; affection and emotion are overpowering. We have

[1] Proceedings of the Royal Society; Obituary Notice of William Thomson, Baron Kelvin. By J. L. Pp. i+lxxvi.
"Lord Kelvin, an Account of his Scientific Life and Work." By Dr. Andrew Gray, F.R.S. (English Men of Science Series.) Pp. ix+318. (London: J. M. Dent and Co., 1908.) Price 2s. 6d. net.
"Kelvin in the Sixties." By Prof. W. E. Ayrton, F.R.S. An article in the *Times* Engineering Supplement, January 8, 1908.
"The Kelvin Lecture." By Prof. Silvanus P. Thompson, F.R.S. Proceedings of the Institution of Electrical Engineers.

been under the spell of the presence of a truly great man; it is impossible to describe our experiences. We loved him as no master was ever before loved by his disciples. We know something of the greatness of his work, but we are too close to him to measure its real grandeur. It is only at far-away Interlaken that one can see the magnificence of the Jungfrau; it will be a hundred years hence that anybody will be able to write justly about Kelvin. That Ayrton should write as he has done was a thing astonishing to many, but quite expected by us. That Larmor should have written as he has done has filled us with unspeakable pleasure.

## *THE STATURE OF THE RACES OF EUROPE.*

THE spread of interest in anthropometry during recent years is clearly indicated in the second part of Dr. Deniker's treatise on European ethnography, which has just been issued by the Association Française pour l'Avancement des Sciences. A comparison of the data collected by the author in this paper with those he was able to draw on for his Huxley memorial lecture in 1904 shows that all over Europe active work is in progress, and that many of the gaps in our knowledge of the physical characters of the living populations are being rapidly filled.

In the present paper Dr. Deniker has supplemented his observations on the cephalic index published in 1899 by a study of the average stature of the male population of the various territorial units of Europe, the results being shown by means of varying shades and colours on a large-scale map. There are separate shades for each difference of twenty-five millimetres in average stature between 1599 and 1725.

The greater part of the material available for study consists of returns of the stature of conscripts in the various countries, and unfortunately the mode of return employed is not uniform. In some States the returns include the stature of all called up for service, whether ultimately enrolled or not, while in others the figures for those rejected from military service on account of deficiency in physique or other causes are omitted. To obviate as far as possible the difficulty arising from this difference of method Dr. Deniker has designed and applied various correction factors. In the main these have consisted in adding one centimetre to allow for growth subsequent to the age of twenty, when the average was based on the stature of all called up for service, whether ultimately accepted or rejected; to make no change when the stature of accepted individuals only was recorded, the deficiency of the rejected being regarded as a counterpoise to the subsequent growth of the recruits actually enrolled; and to deduct a centimetre from the average when it was based on measurements of soldiers between twenty-two and twenty-five years of age.

Dr. Deniker would seem to have utilised every possible source of information, with the result that the bibliography appended is most exhaustive, and is particularly valuable in its references to publications in the various Slavic languages. The value of the averages as recorded on the map shows wide variation, since they are based in some cases on thousands of observations, and in others only on tens. This is pointed out in the text, but it might be possible in a succeeding volume to indicate by shading, not, as in this case, the actual average, but the range within which subsequent series of averages might be expected to fall.

Information is absolutely lacking from very few districts, chiefly small areas in Russia and the Balkan peninsula, though in these countries recent work has done much to fill up the gaps appearing in previous maps of the distribution of physical characters. Far more regrettable is the fact that there are no returns at all of stature from North Germany other than Schleswig-Holstein and part of Mecklenburg. This is the more astonishing when we consider the standing and the activity in other directions of the German school of anthropology.

The map shows that the populations with the tallest average stature are to be found bordering on the shores of the North Sea and the Baltic in the British Isles, Scandinavia, Finland, and Esthonia. These people, also characterised by long heads and fair or light brown hair, are termed by Dr. Deniker the Nordic race. This term is coextensive with Teutonic, the designation more commonly employed in this country, but presents the advantage of being less liable to misconception.

The word Teutonic is rapidly tending to become as comprehensive and therefore useless as the word Celtic.

Another zone of tall populations stretches up through the Balkan peninsula into Central Europe as far as the Tyrol, and a third is situated in the Caucasus.

These latter populations are broad-headed, and, as has been pointed out by Prof. J. L. Myres, very probably represent a race which entered Europe at the close of the Ice age from the Anatolian highlands, and are referred to by Dr. Deniker as the Adriatic or Dinaric race.

Short statures predominate in two great centres, Russia, where the population is in the main broad-headed, and the Italian and Iberian peninsulas, where long-headedness is the rule. The former group is termed the Oriental race; the latter, usually referred to in this country as the Mediterranean or Iberian race, has been divided by Dr. Deniker into two groups, according to stature. Where the average exceeds 165 centimetres he refers to a population as belonging to the Atlanto-Mediterranean race; where it is below this level he terms them Ibero-Insular. Since in other characters the two groups are very similar, it would seem doubtful if the subdivision were quite necessary. The remaining populations of Europe are of intermediate stature.

The division of the European populations into northern and southern long-headed groups, the former characterised by tall stature and fair hair, and the latter by short stature and dark hair, rests on plainly established foundations, and all the members of each group are clearly related, though it is uncertain whether the two main groups had a common origin in comparatively recent times. The relations of the central European broad-headed group are less clear, and further research is needed to determine the affinities, if any, of the Cevenole or Alpine race of short broad-heads with the short eastern European broad-heads who chiefly speak Slavic languages and the taller Balkan and Caucasian broad-heads. It is only by more complete knowledge and detailed analysis, such as characterises the present work, that we may look for answers to these and allied problems.

The value assigned to the population of the British Isles in Dr. Deniker's map is probably an example of the dangers of incomplete surveys. From the figures obtainable chiefly from the report of the British Association Committee in 1883, and the work of Haddon and Browne, Beddoe, Gray and Tocher, it would seem that this country presents the highest average stature of Europe. It is to be feared this estimate, based on somewhat small numbers, is too favourable. The impression gained on returning to England after a tour in Scandinavia is scarcely that of the superiority of the English physique. The probable explanation is that the majority of the recorded observations in this country has been made in rural districts, while the actual majority of the population has been subjected to urban influences.

During the last few years a large number of measurements of children in our large towns have been made in connection with the study of school hygiene, and afford data for comparison with the series obtained in Stockholm by Axel Key, and it may be noted that at all school ages the Swedish children show a distinct superiority both in stature and weight. Indeed, the British children present averages very nearly the mean between the Swedish and Italian averages, which would agree well with the view that both Teutonic and Mediterranean races are represented among the present-day English in about equal proportions.

A final feature of great interest recorded in Dr. Deniker's work is the distinct increase in stature which has taken place during the last half-century among several of the European populations, chiefly those which have participated in the general amelioration of social conditions and improvements in hygiene without being to a great extent subjected to urbanising influences.

Further investigations into national physique are urgently needed from the economic and public health standpoint, as well as to elucidate the problems of the systematic anthropologist. It is to be hoped that in time a detailed survey of this country may be undertaken, and that the results may be available for subsequent volumes of Dr. Deniker's comprehensive and illuminating work.

## *ARTHUR LISTER, F.R.S.*

By the death of Mr. Arthur Lister, F.R.S., which, as announced in our issue of July 23, took place at his residence at Leytonstone, Essex, on Sunday, July 20, the science of cryptogamic botany has sustained a severe loss. The deceased gentleman, who was a J.P. for his native county, was the son of the late Mr. J. Jackson Lister, F.R.S., of Upton, Essex, where he was born in the year 1830. He was a brother of Lord Lister, and in 1855 married Susanna, daughter of the late Mr. William Tindall, of East Dulwich. From an early period of his career Mr. Lister devoted himself to the study of the Mycetozoa, a group formerly classed with the funguses, but now, largely owing to his researches, allowed to rank as a group of equal value by itself, characterised specially by the peculiar mode of development of its members. In addition to numerous separate papers on the subject in the journals of various scientific societies, Mr. Lister wrote the valuable "Monograph of the Mycetozoa," published in 1894 as one of the well-known British Museum catalogues. Since the date of its appearance this thick green volume, which is illustrated by a large number of plates and text-figures in black and white, remained the standard work on the subject. By the lapse of time it had, however, as a matter of course, become out of date, and, until incapacitated by failing health, Mr. Lister, aided by his daughter, was engaged on preparing a new and enlarged edition.

The issue of this work, as we have been kindly informed by the keeper of the botanical department of the Museum, will not be stopped by the demise of the senior author, Miss Lister having undertaken the task of bringing it to completion single-handed. The new edition will be far superior to its predecessor in the matter of illustrations, these including a number of plates reproduced by the three-colour process from Miss Lister's sketches.

In addition to cataloguing the species in the Museum collection, Mr. Lister gave in the original edition of this work a valuable account of mycetozoan development and physiology. Mr. Lister joined the Linnean Society so long ago as 1873, serving on the council from 1891 to 1896, and as a vice-president during the last year of this term of office. In 1898 he was elected a Fellow of the Royal Society.

## *NOTES.*

On August 5, 1858—fifty years ago—the work of laying the first Transatlantic cable was completed, and telegraphic communication was established between Great Britain and America. As is well known, the cable failed to transmit after a few weeks, but the practicability of connecting the two countries electrically had been demonstrated, and the jubilee of this enterprise cannot be passed without a word of congratulation.

Count Zeppelin started in his airship from Friedrichshafen at 6.45 a.m. on August 4, and after passing over Bâle, Strassburg, and Karlsruhe, reached Mannheim at 2.40 p.m. A descent was made near Oppenheim at 6 p.m., and the journey was continued at 10.15 p.m. The airship passed over Mainz at 11.0 p.m., and then headed up the Rhine for the homeward journey, reaching Mannheim at 1.45 a.m. on August 5, Eppingen at 4 a.m., and Stuttgart at 6.20 a.m., where, according to the latest telegrams, it broke away from its moorings and caught fire during a storm, and disappeared into the air, Count Zeppelin being safe.

The Paris correspondent of the *Times* reports that the Russian Government has offered a prize of 50,000 roubles (5000*l.*) for a flying machine competition which is to take place next year at St. Petersburg between July 1 and August 15.

The annual meeting of the French Association for the Advancement of Science was opened at Clermont Ferrand on August 3, when the gold medal of the association was presented to Sir William Ramsay, K.C.B., F.R.S.

The President of the Board of Trade has appointed Lord Rayleigh, P.R.S., Prof. J. J. Thomson, F.R.S., Dr. R. T. Glazebrook, F.R.S., Sir John Gavey, C.B., and Mr. A. P. Trotter to be the British delegates to the International Conference on Electrical Units and Standards which is to assemble in London on October 12. Mr. W. Duddell, F.R.S., and Mr. M. J. Collins, of the Board of Trade, will act as secretaries to the British delegates, and Mr. F. E. Smith and Mr. C. W. S. Crawley as assistant secretaries.

At the meeting of the Royal Society of Edinburgh on Monday, July 20, Dr. R. H. Traquair, F.R.S., vice-president, in the chair, the following prizes were presented in accordance with the award of the council:—(1) the Keith prize for the biennial period 1905–7 to Dr. Alexander Bruce, for his paper entitled "Distribution of the Cells in the Intermedio-lateral Tract of the Spinal Cord," published in the Transactions of the society within the period; (2) the Neill prize for the triennial period 1904–7 to Mr. Frank J. Cole, for his paper entitled "A Monograph on the General Morphology of the Myxinoid Fishes, based on a Study of Myxine," published in the Transactions of the society, regard being also paid to Mr. Cole's other valuable contributions to the anatomy and morphology of fishes.

AT Tavistock on July 20, Colonel G. F. O. Boughey, R.E., and Mr. H. A. Steward, Light Railway Commissioners, sanctioned a line on a gauge of 4 feet 8½ inches to be constructed on Dartmoor near the famous Merrivale avenues of stones, provided that the line "be put quite 200 feet away from the Menhir." Mr. Hansford Worth, who gave evidence at the inquiry against the line, pointed out that the railway would pass through a remarkable group of prehistoric monuments, and that the embankments would interfere with the view. Mr. R. Burnard also strongly protested against the construction of the line, and read a letter from the president of the Society of Antiquaries deprecating any encroachment upon the ancient remains, which are almost unique in character. These protests, however, availed little, for the line may be brought within seventy yards of the avenues, and will in all probability lead to the destruction of the Merrivale antiquities, which are to a great extent unprotected. It is apparently too much to expect that our ancient monuments shall be protected by the State from the interference of company promoters. No doubt it is of commercial importance to convey granite from quarries easily, but this is not sufficient reason for carrying a line near ancient monuments which can never be replaced when once destroyed.

THE recently published report (Cd. 4202) of the Royal Commission on the Care and Control of the Feeble-minded will be followed by seven other volumes detailing the evidence taken by the Commission. The Commission was appointed in September, 1904. It appears from the report that the total number of mentally defective persons, including certified lunatics, in England and Wales, may be estimated to be 271,607, or 0·83 per cent. of the population. Excluding those certified, it is estimated, as a result of medical investigations, that in urban districts 12·7 per cent., and in rural areas 18·75 per cent., of the population in Poor Law institutions are "mentally defective." The Commissioners consider that from 60 per cent. to 70 per cent. of the habitual inebriates dealt with under the Inebriates Acts are mentally defective. They refer to heredity and mental defect, and sum up the effect of the evidence under three heads :—(1) That both on the grounds of fact and of theory there is the highest degree of probability that "feeble-mindedness" is usually spontaneous in origin—that is, not due to influences acting on the parent—and tends strongly to be inherited. (2) That, especially in view of the evidence concerning fertility, the prevention of mentally defective persons from becoming parents would tend largely to diminish the number of such persons in the population. (3) That the evidence for these conclusions strongly supports measures, which on other grounds are of pressing importance, for placing mentally defective persons, men and women, who are living at large and uncontrolled, in institutions where they will be employed and detained; and in this, and in other ways, kept under effectual supervision so long as may be necessary.

SURPRISE has been expressed that the provisional programme of Section A of the British Association was not published last week with the draft programmes of other sections for the meeting to be held in Dublin next month. We regret that the programme did not reach us with the others, but it has now been received, and is as follows :—The address of the president of the section, Dr. W. N. Shaw, F.R.S., will be delivered on the Thursday morning, September 3. Discussions have been arranged on (1) the isothermal layer of the atmosphere, to be opened by M. Teisserenc de Bort; (2) the theory of wave motion, to be opened by Prof. H. Lamb, F.R.S. The section will also join with Section G in a discussion on gaseous explosions. *Papers:* Sir John Moore, is our climate changing? Commander Campbell Hepworth, R.N.R., a comparison of the changes in the temperature of the waters of the North Atlantic and in the strength of the trade winds; J. T. Craig, changes of atmospheric density in storms; E. M. Wedderburn, seiches and their relation to atmospheric phenomena, also temperature conditions of Scottish lochs; G. T. Walker, seasonal variations; Prof. H. H. Turner, on the relation between intensity of light, time of exposure, and photographic action; Rev. A. L. Cortie, S.J., on the possible existence of steam in the regions of sun-spots; Prof. F. W. Dyson, the systematic motions of the stars; Sir R. S. Ball, a generalised instrument; A. P. Trotter, position of the mercury ohm in British legislation; Sir O. J. Lodge and B. Davies, on the measurement of large inductances containing iron; Prof. A. M. Worthington, a remarkable feature in the splash of a rough sphere; Prof. J. A. McClelland, secondary radiation; G. A. Hemsalech, on new methods of obtaining the spectra of flames; Sir Wm. Ramsay, K.C.B., do the radio-active gases (emanations) belong to the argon series? T. Royds, further experiments on the constitution of the electric spark; H. Stansfield, secondary effects in the echelon spectroscope; Dr. W. G. Duffield, photographs of the spectra of metals under pressure; Dr. J. A. Harker and F. P. Seaton, on the effect of pressure upon the boiling point of sulphur; Prof. F. T. Trouton, analogy between adsorption from solutions and aqueous condensation on surfaces; Dr. S. H. Burbury, on the law of equipartition of energy between correlated variables; Lieut.-Colonel Allan Cunningham, factorisation of the A.P.F. of $N=(y^n \mp 1)$; Dr. J. W. Nicholson, the self-inductance of two parallel wires; Sir R. S. Ball, physical applications of linear vector functions; Dr. E. W. Hobson, on Sir W. Hamilton's fluctuating functions; Prof. F. Purser, on the æther-stress of gravitation; Prof. A. W. Conway (title not received); Prof. E. T. Whittaker (title not received); Sir Howard Grubb, a particular form of double-image telescope, also the new spectroheliograph for the Madrid Observatory; F. J. M. Stratton, the constants of the lunar libration; Dr. J. W. Nicholson, the asymptotic expansions of Bessel functions. The reports of the various committees connected with the section will also be read.

INVERTEBRATES from the Upper Cretaceous of Need's Camp, Buffalo River, constitute the subjects of the first part of vol. vii. of the Annals of the South African Museum, Mr. W. Lang, of the British Museum, treating of the polyzoans and corals, while the sea-urchins and their allies, the brachiopods, and the bivalve molluscs are described by Mr. H. Woods, of Cambridge.

THE migrations of flat-fishes and crabs continue, according to the report for 1907, to engage the attention of the staff of the Northumberland Sea Fisheries Committee, and it appears to be established in the case of the latter that while the females travel north, the males are more or less stationary. A large portion of the report is occupied by a paper by Miss M. V. Lebour on the trematodes infesting fishes on the Northumberland coast, in the course of which several species, presumably unrecognised by previous writers, are named and described.

THE articles in the first part of vol. xci. of *Zeitschrift für wissenschaftliche Zoologie* are all devoted to the anatomy of invertebrates, and treat of subjects for the most part interesting to the specialist. Mr. R. Demoll, for instance, discusses the mouth-parts of solitary bees, while the structure of the median eye of the ostracod crustaceans forms the subject of a paper by Dr. M. Nowikoff, and Mr. Walter Döring describes the structure and development of the female reproductive organs of certain cephalopods.

A SYSTEMATIC monograph, by Dr. J. J. Tesch, of the heteropodous molluscs included in the family Atlantidæ, with a list of the species represented in the museum collection, forms the subject of an article in the first part of vol. xxx. of Notes from the Leyden Museum. The author, who states that the group has received but little attention for many years, recognises three genera, one of which is for the first time named and described, the characteristics on which these are based being drawn partly from the shell and partly from the "animal."

To the July number of the *Zoologist* Mr. S. M. Perlmann contributes a paper entitled "Is the Okapi Identical with the 'Thahash' of the Jews?" The word "thahash" has been translated "badger" and "dolphin," but both these readings are conjectural. The Talmudists, according to Mr. Perlmann, considered it, however, to be a ruminant, of a beautiful colour, with a single horn on the forehead. To a great extent, apparently on account of the presence of "a horn-like elevation at the root of the nose" in the okapi, the writer of the paper identifies it with that animal. Apart from the improbability of an exclusively equatorial animal being known to Moses (although the possibility of skins being imported from the south into Egypt may be admitted), the Talmudists' description of the "thahash" does not accord with that of the okapi, of which the males carry a pair of well-developed horns on the forehead—a fact with which Mr. Perlmann appears to be unacquainted. The slight swelling on the nose of the female can scarcely be described as horn-like.

AMONG the biological papers in the July issue of *Science Progress*, special interest attaches to one by Mr. W. A. Brend on tuberculosis in animals. After referring to the fact that recent investigations on the subject have been conducted on two lines—one into the effects produced on animals by the bovine tuberculosis bacillus, and the other by that of human tubercle—the author points out that the animals forming the subject of experiment may be arranged, according to their relative degree of susceptibility to the human disease, in the following order, commencing with those exhibiting the greatest approximation to immunity, viz. rats and mice; dogs; cats; pigs, goats, and cattle; rabbits; and guinea-pigs, monkeys, and apes. It will not fail to be noticed that the immunity is greatest in those brought most closely into association with man. In regard to the fact that rats and mice occupy the highest position in respect to immunity, it has to be borne in mind that although in the ordinary sense these creatures can scarcely be regarded as domesticated animals, yet in a scientific sense their association with man is extremely intimate. They inhabit, for instance, his cellars and sewers, and feed upon the infected sweepings of the streets and pavements. It would be of great interest to ascertain the degree of immunity presented by field-mice.

LITTLE by little we are learning that most of the edentulous or partially edentulous mammals possess germs or other vestiges of teeth in the earlier stages of their existence, and the importance of discoveries of this nature can scarcely be overrated, since they are alone practically sufficient to demonstrate the truth of the doctrine of evolution. The latest addition to the list of mammals with such vestiges is the pangolin group (Manidæ), the members of which are completely devoid of teeth. According to a paper by Dr. H. W. Marett Tims, published in vol. xlii., part ii., of the *Journal of Anatomy and Physiology*, the jaws of a fœtus of one of these animals were found to be provided with minute pointed outgrowths, which there is every reason to regard as vestigial tooth-germs rather than hair-follicles. Some of these structures arise from the alveolar margin of the jaw, while others grow from the outer side, and if they were hair-follicles some of the hairs would fringe the alveolar margin, and others would grow outwards into the substance of the cheek. So far as can be determined, the histological structure of these growths suggests teeth rather than hairs. Assuming them to be the former, they indicate that the formula of the vestigial dentition is $\frac{3}{13}$ or $\frac{3}{14}$, that the teeth in the middle of the series were the largest, while all were apparently of a simple peg-like type, recalling those of armadillos.

THE two recently published parts of the *Annals of Tropical Medicine and Parasitology* (vol. ii., Nos. 2 and 3) contain a number of memoirs of great interest. Drs. Kinghorn and Montgomery report on the etiology and prophylaxis of diseases caused by trypanosomes in man and domestic animals in northern Rhodesia, and discuss incidentally the vexed question of the relation of big game to tsetse-fly disease. Messrs. Salvin-Moore and Breinl, with the collaboration of Dr. Hindle, continue their investigations upon the life-history of trypanosomes, and deal with that of *Trypanosoma lewisi*, the parasite of the common rat. A brief but pithy memoir by Dr. E. H. Ross deals with the prevention of dengue fever, by destruction of mosquitoes, in Egypt.

AMONGST parasitic protozoa, the genus commonly named Piroplasma, but more correctly Babesia, is one which has attracted great attention by its pathogenic properties, and has also given rise to much discussion concerning its systematic position, more especially as regards its relationship on the one hand to the Hæmosporidia, on the other hand to the Flagellata. Major Christophers, in his recent monograph on the development of Piroplasma in the tick, was unable to find any flagellated stages. Miyajima, however, announced (*Philippine Journal of Science*, ii., 2) that he had obtained true trypanosome-forms in a culture of a bovine Piroplasma. Drs. Breinl and Hindle state that in dogs infected with *P. canis* they have found biflagellate forms in small numbers in the peripheral blood of dogs on the day before death (Ann. Trop. Med. Parasitol., ii., 3). Their results appear to confirm the views of Laveran and Mesnil as to the affinities of Piroplasma with the genus Leishmania, the parasite of kala azar.

A SECOND portion of the "Flora of Glamorgan," dealing with the Calyciforæ, has been issued under the editorship of Dr. A. H. Trow. Besides providing a full list of localities and the Welsh names, the critical notes appended by the editor add to the interest of the work, and suggest points that require further confirmation. It is noted that *Medicago sativa* and *Melilotus arvensis* can flourish on the sterile red marl, and *Onobrychis viciaefolia* thrives on the marl, but dies off in the second year on the Lias. The gean is regarded as native to the county, but the claims of the bullace and the dwarf cherry are considered more dubious. The flora is being published as a supplement to the Transactions of the Cardiff Naturalists' Society.

As in forest management we have much to learn from our Continental neighbours, it is well to ascertain the practice adopted in those countries. Mr. J. F. Annand contributes to the Transactions of the Scottish Arboricultural Society (vol. xxi., part ii.) his impressions of forestry in the Schwarzwald, observed during a course of training in the province of Baden. The silver fir generally provides the main crop, except at the higher altitudes, when spruce is the prevailing species. A small proportion of beech is found useful, but is carefully restricted. It is interesting to compare the observations recorded by Mr. Annand with the notes on the cultivation of hardwoods offered by Mr. J. Boyd. The latter, although he recommends growing coniferous and hardwood forests on separate areas, recognises that successful results can also be obtained with a mixture of both classes.

A NOTE in the *Trinidad Bulletin* (April) directs attention to the fact that the tree *Spathelia simplex*, belonging to the order Rutaceæ, is similar to the Agaves in so far as the plant grows for several years before it flowers, and then exhausts itself in the flowering and dies. A specimen that recently flowered belonged to the second generation, since the tree was introduced twenty-two years previously. In the same number will be found a detailed description of the pollination of the papilionaceous flower *Clitoria arborescens* that points to its being a complex process. Put shortly, the pollen from the stamens falls or is brushed by hairs on the stigma into a carinal pouch; the movement of bees and wasps searching for nectar causes the shedding of the pollen on to the vexillum; thence it is transferred by ants or other insects to the stigma. The flowers are inverted, and it has been demonstrated that they are self-sterile.

THE enormous advantages gained by the introduction of rapid methods for fat determination in milk has led E. B. Hart to describe in a special Bulletin (No. 156 of the University of Wisconsin) a rapid method for estimating casein in milk. The milk is mixed with chloroform to dissolve the fat, and dilute acetic acid to coagulate the casein; it is then rapidly rotated in an apparatus not unlike that used in the ordinary Gerber test, and the percentage of casein directly read off by measuring the space occupied by the clot. The trial analyses are very satisfactory, the results agreeing well with those obtained by the official method; if further work shows that the method is trustworthy, it will prove very useful to dairy chemists.

FOLLOWING up his past work on the haustorium of *Santalum album*, Mr. C. A. Barber, in No. 4 of the Memoirs of the Department of Agriculture in India, describes in detail the parasitism of *Olax scandens*. This plant is a sprawling shrub growing in the midst of thickets, thorny, with whitish sweet-scented flowers, and occurs all along the east coast of the Madras Presidency and for a considerable distance inland, chiefly at low elevations. It develops at first like an ordinary non-parasitic plant, and is capable of living for a long period on the nutriment stored in its endosperm, and, later, in its swollen stem and tap-root. There is a well-developed root system with abundant root-hairs even in old plants, and this fact, coupled with the comparative rarity of haustoria in the earlier stages of growth, suggests that the parasitism is in a somewhat elementary stage. The memoir is very well illustrated.

IN connection with an account of the observation of local earthquakes at Mt. Tsukuba in 1905 (Publications of the Japanese Earthquake Investigation Committee, No. 22 A), Prof. Omori discusses the least limit of motion which is sensible, and finds that the lower limit was a double amplitude, or range of motion, of 0·013 mm. for earthquakes unaccompanied by sound; where the earthquake was accompanied by sound, and the vibration probably more rapid, this limit fell to below 0·01 mm. In an earlier investigation of artificial vibration he had determined the minimum acceleration, which was sensible as 17 mm. per sec. per sec. These quantities give a numerical value of the feeblest earthquake which is ordinarily sensible to human beings favourably situated for noting the shock.

IN the Bulletin of the Japanese Earthquake Investigation Committee, vol. ii., No. 1, Prof. Omori deals with the annual variation in the frequency of earthquakes at Tokio and Kioto. Of the eighteen destructive and semi-destructive earthquakes which have been recorded at Tokio, seven occurred in summer and five in winter, but only three each in winter and spring; small earthquakes, on the other hand, are most frequent in winter and spring, and least frequent in summer and autumn. At Kioto the greatest frequency of small earthquakes is in March, the minimum in September; of great earthquakes, the maximum frequency is in August and the minimum from February to April, no destructive earthquakes having been recorded in these months. It will be seen that, as regards great and small earthquakes respectively, the frequency at Kioto is the reverse of that at Tokio, but in each case the frequency of one class of earthquakes is greatest when that of the other is least. The author has found that the same relation holds good for the earthquakes of Japan as a whole, and for the submarine earthquakes off the coast of Japan.

THE Geological Survey of Canada has issued a bulletin (No. 979) containing a report by Mr. R. G. McConnell on work done in the Klondike during the past season. The object in view was to estimate the recoverable values remaining in the high-level gravels along Bonanza and Hunker creeks, and in a portion of the Klondike valley, and also to obtain as much information as possible in regard to the values remaining in the low-level or creek gravels. The author estimates that gold to the value of 18,950,000*l*. has been produced in the past, and that the value of the recoverable gold remaining is 10,728,524*l*. While it is unlikely that any large area of rich gravel has escaped detection, minor discoveries may be expected so long as mining lasts, and on this account any estimate is apt to be somewhat under rather than over the mark. The report is accompanied by a large coloured contoured map of the auriferous gravels on Bonanza and Hunker creeks on a scale of 40 chains to the inch. In another bulletin (No. 992) issued by the Survey, Mr. W. H. Collins gives a report on a portion of north-western Ontario traversed by the National Transcontinental Railway between Lake Nipigon and Sturgeon Lake. All the rocks of the territory explored are pre-Cambrian and almost wholly crystalline. The Keewatin green schists are the most interesting series in that they are gold and iron bearing. Gold is mined on Sturgeon Lake, and very promising iron-ore deposits have been opened up near Lake Nipigon. The report is accompanied by a large coloured geological map of the district on a scale of 4 miles to the inch.

MR. A. J. PHILIP contributes to the July number of the *Reliquary* a useful article on the dene-holes of Kent and

Sussex. The name usually given to these remarkable structures probably connects them in popular tradition with the Danes. The writer reviews the many theories which have been advanced to account for their origin—that they were flint-workings; places of secret worship and repositories for the remains of the dead; underground dwellings or hiding-places; excavations for the extraction of chalk. All these are found to be inadequate. The amount of flint which could have been obtained in such places is insignificant, and no attempt seems to have been made to work the small existing supplies; there is no evidence that they served any purpose in connection with a religious cultus; the existence of many excavations within a limited area renders it improbable that they were dwelling-places or refuges, their contiguity exposing them to simultaneous hostile attack, while their construction offers no facilities for escape; their character shows that the removal of chalk was not the primary intention. Mr. Philip favours the supposition that they were intended to be used as silos, or underground granaries, and most of the arguments adduced in opposition to the other theories contribute to establish this view. Thus they were naturally close together, because the tribe clustered within a narrow area. The principal objection is the risk of damp; but, as a matter of fact, the caves seldom show signs of being affected by underground moisture, and perishable grain was probably protected by thick surrounding layers of straw. That they were not the work of a single age is shown by the fact that the character of the pick-marks varies; in the older specimens we find marks of horn, bone, and flint tools; in those of a later date metal implements were used. The shaft is invariably some 3 feet in diameter, and seldom less than 60 feet in depth, ingress and egress being provided by means of a rude ladder or by ropes of hide.

THE Deutsche Seewarte has recently published a double number (Heft 15 and 16) of its collection of over-sea meteorological observations, referring chiefly to the years 1905–6. The work includes (1) monthly and yearly means of eye observations and automatic records made under the supervision of the Seewarte at twenty-five stations; (2) individual observations and hourly means at a number of selected stations in German East Africa. The whole of the tables give evidence of great care in their preparation for publication, to the cost of which the Imperial Colonial Office contributes; they furnish a very valuable contribution to the meteorology of various remote parts of the globe. We are glad to note that, in cases where only summaries are printed, the original documents are available on loan for the purpose of scientific investigations under reasonable restrictions as to their safe return.

FIVE years ago M. Ivar Fredholm published in the *Acta Mathematica* a remarkable memoir which seems likely to prove the starting point of a host of important results, both in function-theory and in mathematical physics. One of the latest works to which it has given rise is the thesis of Dr. H. Bryon Heywood, "Sur l'Équation fonctionelle de Fredholm et quelques-unes de ses Applications" (Gauthier-Villars, 1908). In this the author gives a summary of the results of Fredholm, Picard, Poincaré, and others, and gives applications to heat-conduction, tides, potential, &c. The first chapter contains an extension of some propositions of Hilbert's; this appears to be the most original part of the thesis, but the whole is worth reading, because it brings a variety of problems under the same treatment.

THE *Physical Review* for June contains a communication from Messrs. A. H. Taylor and E. H. Williams, of the University of Wisconsin, on the distributed capacity of resistance boxes. They find by the modified bridge method used by Messrs. Rosa and Grover for comparing inductances, that the capacity of the ordinary Wolff 1000-ohm coil is 0·0005–0·0006 microfarad, while that of a 1000-ohm coil wound on a wood core is only 0·00007 microfarad. Wolff 500-ohm coils give 0·00010–0·00022 microfarad, and 2000-ohm coils 0·00041–0·00063 microfarad. The authors attribute the high capacities of Wolff coils mainly to the comparatively large wire used in constructing them, but also to the shellac between the wire and the brass tube on which it is wound not being thoroughly dry. It seems evident from these results that resistance coils must be used with great discrimination in accurate alternating current measurements.

IN May last M. C. Féry gave before the Société française de Physique an account of the methods he had in succession adopted, in his endeavour to produce a pendulum electrically driven, which should be accurate to within a second a day. His communication is printed in full in the July number of the *Journal de Physique*, and from it we gather that the arrangement he finds most satisfactory is one in which the pendulum carries beneath the bob a horse-shoe magnet, the plane of which coincides with the plane of swing of the pendulum. The lower of the limbs of the magnet enters during its swing a fixed coil, and the upper a small copper ring which forms the bob of a second pendulum having the same time of swing as the first. This ring is carried along with the moving magnet owing to the currents induced in it, and makes or breaks the circuit of the fixed coil, through which a current from a cell in series with it flows in consequence in such a direction as to supply the small impulse necessary to compensate for the decay of swing of the principal pendulum owing to friction. The same arrangement is adopted by M. Féry in controlling a number of distant pendulums by means of a central standard.

WHEN sufficiently fine solid particles are suspended in a liquid they exhibit under a high-power microscope rapid motions which are known, from their discoverer, as "Brownian." These movements form the subject of an interesting study by Dr. M. Seddig in the *Physikalische Zeitschrift* for July 15. The particles were of cinnabar, a quantity of which was stirred up with the liquid and allowed to stand in a long tube for a week. The top layer of liquid was then decanted, and a drop of it arranged as a slide in a microscope fitted with a camera. An arc light provided the strong illumination necessary. By means of a falling shutter with two holes in it, two exposures, each of 1/40 second and 1/10 second apart, were made, and the motions of a number of the particles between the two exposures measured on enlargements of the original plates. As the result of observations made on the same liquid at different temperatures, Dr. Seddig comes to the conclusion that the theory of these movements given by Einstein, according to which they should vary in intensity as the square root of the absolute temperature, is in keeping with the facts.

DR. F. A. BATHER proposes to publish a double index to the generic and specific names in E. Desor's "Synopsis des Échinides Fossiles," a work still in constant use by every worker on the Echinoidea. This index will be preceded by a "Note sur les Dates de Publication," drawn up by Mr. Jules Lambert. Intending subscribers to the index should communicate with Dr. Bather at the Natural History Museum, South Kensington, S.W.

## OUR ASTRONOMICAL COLUMN.

The Solar Eclipse of December 22–23, 1908.—In a note to No. 4264 of the *Astronomische Nachrichten* (p. 271) Prof. W. Krebs points out that in certain localities in the Antarctic regions the solar eclipse of December next will be total for a few seconds. At Bouvet Island, totality will last for some eleven seconds, during which time, Prof. Krebs suggests, photographs of the corona might be secured. This island is, however, very difficult of access, being situated a few degrees to the west of Cape Colony and very near the Antarctic circle, well within the mean limit of the drift ice; its longitude is about $5\frac{1}{2}°$ E., and its latitude about 54° S.

Observations of Perseids, 1907.—The results of the observations of the Perseid shower at the Paris Observatory on August 11, 13, and 14, 1907, are published, by M. L. Benès, in the July number of the *Bulletin de la Société astronomique de France* (p. 326).

Between 9h. 50m. and 14h. 13m. (M.T. Paris) on August 11, one observer recorded the paths of thirty-one meteors, despite the interference of light clouds, which probably prevented the fainter objects from being seen. Clouds interfered more seriously on August 13, and only four paths were recorded in a watch extending over the ninety minutes before midnight. Sixteen meteors were observed on August 14 during the intervals 9h. 7m. to 12h. 1m. and 12h. 26m. to 13h. 21m.

Of the thirty-one meteors seen on August 11, nineteen were probably Perseids from a radiant at $\alpha=48°$, $\delta=+58°$. Three of those seen on August 13 and three seen on August 14 were probably Draconids. The general colour of the meteors was yellow or yellowish-red, and few of them left trails. The trajectory of a Perseid seen on August 11 showed a break in the middle.

Micrometer Measures of Jovian Features.—In No. 4260 of the *Astronomische Nachrichten* (p. 191, July 3) Dr. H. E. Lau gives the results obtained from his micrometer measures of the various features on Jupiter during the most recent opposition.

The measures of the Great Red Spot confirm the diminution of the longitude of this feature, to which the Rev. T. E. R. Phillips has already directed attention in vol. xviii., No. 6, of the Journal of the British Astronomical Association; they also indicate that the Red Spot belongs to the higher strata of the Jovian atmosphere. The measures of other spots and of the various bands and streaks are also given by Dr. Lau.

Peculiar Orbit of a Spectroscopic Binary.—Observations made at the Dominion Observatory, Ottawa, indicate that the orbit of the spectroscopic binary B.D. $-1°.1004$ has, probably, an even greater eccentricity than that (0·75) of $\iota$ Orionis, for which the elements were recently determined and published; the velocity curve bears a striking resemblance to that of the latter star, and the period is about the same. Observations of B.D. $-1°.1004$ are to be resumed during the coming autumn (Journal R.A.S., Canada, vol. ii., No. 3, p. 161).

Definitive Elements for the Orbit of Comet 1886 V.—Definitive elements for the orbit of comet 1886 V. have been calculated by Herr Gösta Bucht, Upsala, and are published in No. 4264 of the *Astronomische Nachrichten* (p. 257, July 20). The consideration of the least-square residuals in each case establishes the fact that the orbit is elliptical, the length of the semi-major axis being $84{\cdot}073 \pm 1{\cdot}017$; the period of the comet is found to be $770{\cdot}91 \pm 13{\cdot}84$ years.

Astronomical Societies in the Provinces.—Nos. 3–7, vol. x., of the *Cambrian Natural Observer* (February–June) contain the record of the Astronomical Society of Wales during the period they embrace. Among other articles of interest we may mention one on solar spectroscopy, in which General Lee gives a few practical hints to amateur solar observers; an article by Mr. Mee, in which he gives brief descriptions of various large public clocks; and a paper by Miss G. Hagerty, dealing with various optical phenomena. The records of local observers, and a description of the society's exhibition of instruments, photographs, &c., at Cardiff, are also very interesting.

The record of the Leeds Astronomical Society for 1907 is contained in No. 15 of its Journal and Transactions, and includes numerous papers of interest to amateur astronomers. Among these may be mentioned a paper on the transit instrument, by Mr. Spiegelhalter; a review of astronomical research in 1906 by the president, Mr. A. Dodgson; and a *résumé* of the society's work during 1907. Some supplementary notes on Tennyson's astronomy are contributed by Mr. Whitmell.

Bolides observed during May.—In No. 4261 of the *Astronomische Nachrichten* (p. 223, July 13), M. C. Birkenstock, of Antwerp, records the paths, &c., of three fireballs which he observed during May. One of these was seen on May 17, the other two on May 27. Of those seen on the latter date, the second appeared at 12h. 28m. (G.M.T.), and was evidently a remarkable object. As bright as Venus, its colour was reddish-yellow, and it left behind it a trail of yellowish light; the duration of the flight was estimated by M. Birkenstock to be eight to ten seconds, but other observers, reported in No. 7 of the *Gazette astronomique* (p. 53, June 30), give four to six seconds. The path was from 330°, +77°, to 268°, +10°, and, according to the elements published in the latter journal, the bolide travelled 114 km. at a speed of 14·25 km. per second; the heights at the points of appearance and disappearance were 115 km. and 62 km. respectively.

## INSTITUTION OF MECHANICAL ENGINEERS.

For the summer meeting of the Institution of Mechanical Engineers at Bristol an interesting programme of papers was arranged. The president (Mr. T. Hurry Riches) and Mr. B. Reynolds described a system of forced lubrication as arranged for driving axle-boxes of some of the steam-cars of the Taff Vale Railway Company. Mr. C. A. M. Smith gave an account of a method of detecting the bending of columns, for which purpose he has constructed a new type of instrument to which the name "sphingometer" has been given. Mr. William Stagg described the inclined retort coal- and coke-handling plant at Bristol.

An important paper on the evolution and methods of manufacture of spur-gearing was contributed by Mr. T. Humpage. He has designed an ingenious machine for grinding the involute teeth of gear wheels, which works on the principle of the hobbing machine. His idea is that not case-hardened wheels only should be ground on this machine, but every kind of metal should be ground in the soft state, no matter for what purpose the wheels are required. The wheels would be roughed out rapidly in the gear hobbing machine with no attempt at finish, and then sent to the grinding machine to be finished, just as all lathe work that is required to be both accurate and cheaply produced is first roughed out in the lathe and then finished on the universal grinder.

Lastly, Mr. S. O. Cowper-Coles read a paper on the direct production of copper tubes, sheets, and wire by electrolysis from impure copper. The advantages of an electrolytic process as compared to a smelting process are many, and the day is not far distant when copper will no doubt be leached direct from the ore and electrolysed with insoluble anodes, to produce finished copper sheets and tubes in one operation direct from the ore without the intermediate process of smelting and refining.

The centrifugal process is a step in this direction, as it is capable of depositing copper from its solutions by using insoluble anodes in the form of finished tubes or sheets in one operation. The centrifugal process is at least ten times faster than any existing electrolytic process, and a high current density can be employed without deteriorating the quality of the copper. There is no risk of lamination, as no burnishers are employed. The plant is simple and free from mechanical complications, and the amount of copper locked up for a given output is small compared to other processes. The process is of interest to mechanical engineers, as it conclusively proves that to get a high tensile strength in metals, combined with ductility, it is not essential to put a large amount of work into the metals as hitherto has been considered necessary, by the processes of swaging, rolling, or drawing, but that a very small amount of energy will suffice.

## ELECTRICITY IN AGRICULTURE.

SOME thirty years ago Prof. Lemström, of the University of Helsingfors, sought to elucidate the Aurora Borealis by trying to imitate its appearance by electrical experiments. For this purpose he produced high-tension discharges of various kinds, and sent them through vacuum tubes until he got an appearance very like those of the northern lights. Some of these experiments he conducted in his greenhouse—to the best of my belief, according to his own account, given when on a visit to England—and he noticed incidentally that the plants seemed to thrive under the treatment, and that the electrification thus produced in their neighbourhood appeared to do them good. He also noticed, as remarkable, the flourishing development of plants in Arctic regions, where the sunlight was very weak, and he attributed part of this growth to the influence of electric discharges.

He says that when the plants in the north of Norway, Spitsbergen, and Finnish Lapland have resisted the frequently destructive night frosts, they show a degree of development which greatly surpasses that of plants in more southern regions, where the climatic conditions are more advantageous. This rich development appears principally in the fresh and clear colours of the flowers, in their strong perfume, in the rapid development of the leaves on the trees, and their scent, but particularly in the rich harvest which different seeds—such as rye, oats, and barley—will produce, when, as before stated, they are not destroyed by the frosts. From a bushel of rye sown there will often result forty bushels, and from barley twenty bushels, and so forth. It is the same with grass. These results are attained notwithstanding the fact that the people cultivate their soil very imperfectly, using only ploughs and harrows of wood.

He pursued the matter by careful observation, taking test-plants in pairs or groups; electrifying one group—that is to say, discharging some electricity into the air above it—and keeping a similar group away from the electricity, in order to be able to compare them. Then he photographed the two groups side by side, and found in nearly all cases a marked improvement as the result of the electrical treatment. He concluded that the needle-like shape of the leaves in fir-trees, and the beard on the ears of most cereals, have the discharge of electricity as their function; and he found that they do act in this way.

This observation and these experiments of Prof. Lemström were not, indeed, the beginning of the application of electricity to plant growth, because pioneer attempts had been made long before by the Abbé Berthelon in 1783, but it was the beginning of a thorough and scientific treatment of the problem. Prof. Berthelot, at Meudon, has also attacked it; so have Dr. Cook and Mr. J. H. Priestley, of Bristol. During the winter of 1904 Mr. J. E. Newman installed a small trial apparatus, consisting of a small influence machine of the Wimshurst type and overhead discharge wires, at the Golden Valley Nurseries at Bitton, near Bristol. The wires ran about sixteen inches above the tops of the plants, or above the rows of tomatoes in the glasshouses; and short pieces of fine wire, with the free ends pointing downwards, acted as discharge points. Mr. G. R. Newman has now established a large-scale installation there.

Attempts of a different kind had also been made by other experimenters. Plates had been sunk in the ground, and a current passed between them among the roots of plants; but whatever effect is thus caused is of a totally different kind from that excited by high-tension electricity supplied to the air above them. Both in a manner are natural processes. There are natural earth currents, and these must flow among the roots of plants, though whether they produce an appreciable effect may be doubted. There is a natural atmospheric electrification, and this must be playing an important part in many phenomena. Atmospheric electrification is responsible for the coalescence of cloud globules into rain. During fine weather the electricity in the air is usually of one sign: positive. When wet weather sets in, the electricity in the air usually changes sign, becoming negative. The whole subject is a large one; a great deal is known about it, and vastly more remains to be known; but meanwhile it can hardly be doubted that the electrification of the air has some effect on growing plants. For it is found that under the influence of ultra-violet light, electrified plants can give off electricity into the air from the leaves; and the fact that the upper air is normally electrified, relatively to the soil, must cause all plants to be electrified also; so that in all probability they are in a constant state of slow electrical discharge, which becomes more rapid when the sun is up. In what way this discharge of electricity from their growing tips, and hair, and surface generally, really acts, must be studied and reported on by physiological botanists, but it is natural to suppose that it cannot be without influence, and reasonable to think that that influence may be beneficial—a hypothesis which direct experiment confirms.

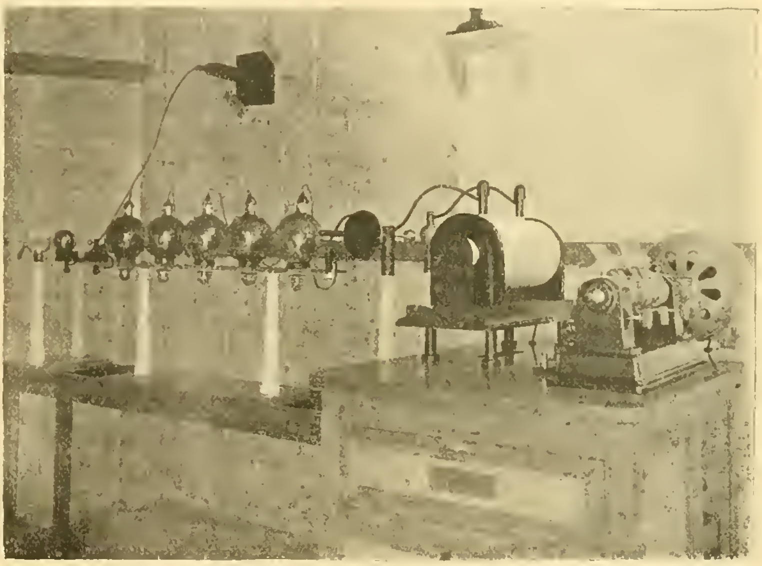

FIG. 1.—Inside the transformer shed, showing the inductive break, special coil, and high-tension valves.

Possibly in some sunny countries the effect is excessive, and might, with advantage, be moderated, but in this climate it turns out that artificial supply of electricity does increase the rapidity and assist the amount of growth. At any rate, the experiments of Lemström, which had been repeated and extended by others, clearly pointed in that direction. So when, after some preliminary experiments at Bitton, Mr. J. E. Newman, of 3 Howard Street, Gloucester, acting in conjunction with Mr. R. Bomford, of Bevington Hall, Evesham, at his farm near Salford Priors, determined to try the phenomenon on a really large scale, and came to me to see if I could help them electrically, and enable them to maintain a continuous high-tension discharge for hours together each day over ten or eleven acres by means of power furnished by an oil engine and dynamo, I very willingly assented, and set my son, Mr. Lionel Lodge, upon the work.

The method is to stretch over the field to be treated a number of wires on poles, something like low telegraph wires, but high enough for loaded waggons and all the usual farming operations to go on underneath the wires without let or hindrance. The wires are quite thin, and are supported by a few posts in long parallel spans, about 30 feet apart. One pole per acre is enough. The electrified area was about 19 acres. The wires are supported on the posts by elaborate high-tension insulators, and they extend over all the acreage under experiment, a control plot of similar land under similar conditions being, of course, left without any wires.

The system of conductors is then connected at one point with a generator supplying positive electricity at a potential of something like a hundred thousand volts, and with sufficient power to maintain a constant supply of electricity at this kind of potential.

Leakage immediately begins, and the charge fizzes off from the wires with a sound which is sometimes audible, and with a glow which is just visible in the dark. Anyone walking about below the wires can sometimes feel the effect on the hair of the head, as of a cobweb on the face. They are then feeling the stimulating action of the electrification.

The electrification is maintained for some hours each day, but is shut off at night; it is probably only necessary

*Control.* *Electrified.*

FIG. 2.—Comparison of electrified wheat with wheat grown in the control field under the same conditions, an average plant being taken in each case. Note the broader leaves and greater number of shoots of the electrified wheat.

to supply it during the early morning hours in summer-time, and in spring-time or in cold cloudy weather for the whole day. During bright sunshine it seems unnecessary, and may even be harmful. But at what stages of the growth of a plant the stimulus is most effective has still to be made out; probably the earlier it is begun the better; and since in the case of wheat both the ear and the straw is valuable, the electrification should be applied for a time each day during the whole period of growth, except perhaps during drought.

The power required to generate the electricity is very small, for although the potential is high, the quantity is insignificant, and the energy is accordingly comparatively trivial. The electricity can be generated in more than one way. It can be generated by a Wimshurst machine, or it can be generated by transforming up to high tension, and rectifying to one direction, the current of a dynamo. The first is in many respects the simplest, and was used in the early and small-scale experiments, but it can hardly be regarded as an engineering method adapted to continuous or rough use. The latter is the one which in the trials now to be described we have adopted.

The power is generated by a two-horse oil engine driving a small dynamo in an outhouse of the farm. Thence the current is taken by ordinary overhead wires to the field, where they enter a suitable weather-tight hut, which contains the transforming and rectifying apparatus. The only moving part here is the "break," and if the original dynamo had been an alternator, even this might be dispensed with. The transformer is a large induction coil, specially made to stand continuous use, and its current is then rectified by means of vacuum valves in accordance with a patented device of my own.

The negative electricity is conveyed direct to earth, while high-tension electricity, all of positive sign, is led by a specially insulated conductor out of the shed to the nearest point of the overhead insulated wires, which are thereby maintained at continuous high positive potential.

THE RESULTS AND FURTHER DETAILS.

The following is a very brief summary of returns and information supplied to me by Mr. Newman and Mr. Bomford, showing the results from the electrified as compared with the control unelectrified plots.

SUMMARISED RESULTS OF THE 1906 EXPERIMENTS.

*Bushels of Wheat per Acre.*

(*Estimated corresponding increase in straw not measured.*)

| | From the electrified plot | From the unelectrified plot | Increase |
|---|---|---|---|
| Canadian (Red Fife) ... ... | $35\frac{1}{2}$ ... | $25\frac{1}{2}$ ... | 40 p.c. |
| English (White Queen) ... | 40 ... | 31 ... | 30 ,, |

Moreover, the electrified wheat sold at prices some $7\frac{1}{2}$ per cent. higher, several millers in baking tests finding that it produced a better baking flour.

The increase appears to be mainly due to better stooling. No marked difference was observable in the development of ears.

SUMMARISED RESULTS OF THE 1907 EXPERIMENTS ON WHEAT.

RED FIFE, SPRING SOWN.

*Bushels per Acre (Head Wheat).*

| Electrified | Unelectrified | Increase |
|---|---|---|
| 41·4 ... ... | 32 ... ... | 29 p.c. |

Electrified wheat brighter, and a better sample.

Increase again partly due to better stooling, but this time there was better filling out of ears.

These results are for wheat alone, but a good many other crops were tried at the same time.

HOURS OF RUNNING.

1906.

March 16 to July 10, inclusive, $621\frac{3}{4}$ on 90 days.
Average electrical pressure corresponded to a $\frac{3}{4}$-in. spark.
Current shut off after ears in bloom.

1907.

March 28 to July 27, 1014 hours on 115 days.
Average pressure corresponded to a half-inch spark.
Current kept on to harvest.

Those interested in the experiments are much indebted to the enthusiastic cooperation of Mr. Bomford. It may be interesting to note that it was at a farm belonging to Mr. Bomford's father that the first steam ploughing in England was done.

Prof. Lemström is undoubtedly the pioneer in this sort of work, though circumstances connected with the natural electrification of the atmosphere and with the discharge of electricity from various surfaces have been pertinaciously examined by Profs. Elster and Geitel.

OLIVER LODGE.

## THE BRITISH MEDICAL ASSOCIATION AT SHEFFIELD.

A VERY successful general meeting of the British Medical Association was held at Sheffield last week, when, under the most agreeable conditions, a considerable amount of valuable work was accomplished by the association.

While there was no dramatic announcement of any epoch-making discovery, or the, often premature, propounding of a theory—such as that relating to the non-transmissibility of bovine tuberculosis to man—which time would fail to substantiate, yet many subjects were discussed of both theoretical and practical interest to the general public.

Among others may be mentioned the problem of infection by typhoid carriers, which was considered in two able and interesting papers by Dr. Ledingham and by Drs. Davies and Walker Hall.

It has been recognised for some time past that the *Bacillus typhosus*—latent yet virulent—may exist in the human organism for years after the acute attack has subsided. Still earlier was the bacillus of diphtheria, in like case, tried and found guilty. Mysterious epidemics, which could not be traced either to direct contact or to infected clothing or towels, or to the milk supply, broke out from time to time in various places. Famous among such epidemics was that which occurred at the Charité Hospital in Berlin, when, by a process of elimination, the responsibility was at last found to rest with a nursing sister, who, without exhibiting any of the signs of diphtheria, was found to harbour the virulent germs in her throat. A small dose of antitoxin was administered, the ordinary precautionary measures were taken, and the epidemic ceased.

Unfortunately, in the case of typhoid, the matter is not so simple. In the first place, the isolation of the *B. typhosus* from the stools—when the systematic examination of many suspects is in question—is a far more arduous undertaking than the technique involved in the search for the *B. diphtheriae* in the fauces. Further, as pointed out by Dr. Walker Hall—and by others before him—the excretion of the bacillus by the carrier is intermittent, and it may therefore be missed unless numerous and systematic examinations be made extending over a period of many months. Even when found, the danger to be feared from the carrier as a focus of infection is not entirely averted, as, up to the present, we have no really trustworthy method of destroying the organism *in situ*.

Dr. Ledingham rightly laid great stress upon the incidence of gall-stone disease in a carrier. The proportion of female to male carriers is three to one—figures which exactly coincide with those appertaining to gall-stone disease; again, only 10 per cent. of the subjects of gall-stone disease show any symptoms, while, curiously enough, 10 per cent. of chronic carriers show symptoms of gall-stone disease.

In view of the above, and of the fact that the *B. typhosus* has been isolated from the gall bladder and stones of such cases, any symptom of hepatic trouble in a typhoid convalescent—or even in a person known to have had typhoid previously—should be viewed with the gravest suspicion. This applies all the more strongly to those whose duties bring them into contact with the food supply of their *entourage*, as, for example, dairymaids, milk vendors, cooks, &c. In any attempt at prophylaxis, the difficulty lies in enforcing, over a sufficiently lengthy period, the necessary regulations. It is not yet known how long the infection of typhoid may remain latent, although the dogma has been enunciated, "once a carrier, always a carrier."

With regard to the periodicity, Dr. Walker Hall showed that a carrier, after remaining innocuous for many months, might suddenly again become infectious and spread the disease far and wide. This always occurred after an illness in which the patient showed diarrhœa and a rise in temperature and pulse rate. An examination of the blood at these times showed a pronounced increase in the number of mononuclear leucocytes, and this Dr. Walker Hall considered a most important diagnostic point, as a differential blood-count can be readily undertaken by the physician in attendance. The greatest number of cases resulting from this form of infection occurred in the warm weather, *i.e.* during the months of July, August, and September. It was suggested, in explanation, that it is during the warm weather that the typhoid organism develops most rapidly in milk; on the other hand, it was pointed out that the lactic acid bacilli are also more active then, and would thus tend to render the milk less suitable a pabulum for the bacillus of typhoid. In conclusion, Dr. Walker Hall presented the meeting with a copy of suggested instructions to typhoid convalescents, which were admirable in their lucidity and simplicity; the only criticism which suggests itself is that he should specify the disinfectant solutions to be used.

In the section of pathology, the mornings of Wednesday and Thursday were occupied with a discussion on cerebro-spinal meningitis. From a practical point of view, the most interesting communications were those relative to the brilliant results obtained by serum treatment; from being almost a hopelessly incurable disease, "spotted fever" may now be regarded as giving a most hopeful prognosis, in view of the reduction in the mortality rate from more than 80 per cent. to between 30 per cent. and 40 per cent.

In the section of dermatology, an intensely interesting discourse was given by Prof. Neisser, of Berlin, in which he communicated the results of his work on the experimental inoculation and treatment of syphilis. The experiments, which were carried out on anthropoid apes in Java, extended over a period of more than three years; the magnitude of the work may be imagined from the fact that from 600 to 800 animals were always under observation. Prof. Neisser's results go far to confirm the dicta already promulgated by Metchnikoff and others, namely, the importance of the prophylactic inunction of a $33\frac{1}{3}$ per cent. calomel ointment at the site of inoculation. Washing with sublimate solution 2 : 1000 and 3 : 1000 also gave good results. The necessity of energetic and prolonged mercurial treatment was insisted upon, or, better still, the chronic intermittent treatment by the combined application of atoxyl—or Ehrlich's arsacetin—and iodine, as well as mercury. The minimum period over which the treatment should be continued was given as four years. In this connection we may notice also the excellent collection of microscopical and lantern slides, demonstrating the presence of the *Spirochaeta pallida* in syphilitic lesions, which were exhibited by Dr. Mackenzie in the section of pathology.

An important discussion took place on Thursday morning in the industrial diseases section, with regard to the relation of pneumoconiosis to phthisis. Although Sheffield, as the great centre in England of the "dusty trades," furnished the greatest number of examples, the questions raised apply equally to all towns where a large number of workmen are subject to the deleterious effects of inhaled dust. Statistics show that in Sheffield the mortality rate from phthisis of adult males engaged in "dusty trades" is five times greater than the average for the rest of England. As pointed out by Mr. Edmund Owen in his popular lecture, the process known as "dry grinding" is responsible in great part for this excessive mortality. In the old days, grinding sheds were placed along the banks of the Don for the sake of the wheel power; plenty of water was at hand, and it was made to drip upon the wheels. With the advent of steam power the old riverside sheds were abandoned, over-crowded, dusty, and ill-ventilated factories took the place of the breezy sheds, and the men became too busy to water their wheels. It is, moreover, asserted that "dry grinding" is more efficient than "wet grinding." However this may be, the introduction of the new process resulted in a startling increase in the mortality rate from phthisis.

It was pointed out that the quality of the dust inhaled is a determining factor of no small importance in the causation of tuberculosis; the more irritating the particles the more dangerous the dust. Colliers, for instance, are particularly subject to anthracosis, and yet the death-rate from phthisis among them is not abnormally high. The first effect of inhaling "grinder's dust" is to produce rhinitis, followed by erosions of the mucous membrane and septal ulcers. This, again, is followed by atrophy of the Schneiderian membrane, and loss of smell. As the process descends, first irritation and then atrophy of the mucous membrane of the pharynx and larynx occur. At this stage the cough induced by the irritating particles becomes "dry" and useless; the entrance of dust into the lungs being thus facilitated, nodules of dust-filled, inflammatory infiltration are formed, which break down and provide a nidus for the tubercle bacillus.

A further argument against the dry-grinding process was brought forward by Dr. Barnes (of Sheffield). He maintained that the great susceptibility of grinders to tuberculosis was due to the fact that the dust amongst which they worked aided in the dissemination of the tubercle bacillus by inducing the rapid drying of the sputum. He pointed out that, whereas now a tuberculous worker spits upon a dusty floor, in the old days he spat into a trough containing water. The speaker, in effect, insisted that "grinder's disease" was pure tuberculosis and not pneumoconiosis, and called upon the contents of the pathological museum to substantiate his contention.

We were surprised to notice that no mention was made of the growing belief that tubercular infection of the lung takes place *viâ* the alimentary canal. Even in the case of the Sheffield grinder this theory would not be antagonistic to the general principles which we know to lie at the root of all systematic infections. It is well known that an infection, no matter how introduced into the system, will always seek out a *locus minoris resistentiae*; in this case it would be a lung weakened by pneumoconiosis. It is now universally recognised that the prognosis in tubercular disease is very largely dependent upon early diagnosis. In a disease such as pneumoconiosis, which so closely resembles tubercle in its clinical signs and symptoms, we were rather surprised that some form of easily applied tuberculin diagnosis—such as Calmette's ophthalmo-reaction—was not mentioned as having been tried, at least to any extent.

The Pathological Museum presented a mass of excessively interesting material, the specimens being, however, for the most part of interest rather to the specialist than to the general public. Among the exhibits having a somewhat wider interest may be mentioned the sections of Egyptian mummy organs shown by Dr. Armand Ruffer. The sections were taken from the mummy of a priest of Amen, and in spite of the fact that the material was at least 2400 years old, the microscopical structure was surprising in its detail and perfection.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—In the faculty of engineering at University College, London, a new lectureship in electrical design has been instituted, and Mr. H. M. Hobart has been appointed thereto. By the assistance of a committee of former engineering students and of other friends of the college, the new laboratories and extensions of the departments of the faculty of engineering, which were opened by the Chancellor, Lord Rosebery, last March, will be further equipped during the present long vacation. The new equipment will include a new boiler in the department of mechanical engineering, a steam turbine, and hydraulic apparatus, and equipment for research in metallography and radio-telegraphy. The facilities for advanced and post-graduate students, as well as for undergraduate students, will thus be considerably increased.

SHEFFIELD.—Dr. Ralph P. Williams has been appointed to the professorship of public health rendered vacant by the resignation of Dr. Harold Scurfield.

By the will of the late Dr. H. J. Hunter, the residue of his property, which will, apparently, amount to between 15,000*l.* and 20,000*l.*, is bequeathed to the University.

AN anonymous gift of half a million kronen (about 20,833*l.*) has been made to the Vienna Academy of Sciences for the establishment of a "Radium Institute" in connection with the new physics laboratories of the University of Vienna.

AN interesting proof of the efficiency of mathematical teaching in Poland in the seventeenth century is afforded by M. H. Merczyng's paper on a mathematical text-book for Polish students under Sigismund III., published in the Bulletin of the Cracow Academy, part x. (1907), recently received. The book in question is a treatise on arithmetic and geometry by Joachim Stegman, who about the year 1630 was principal and professor of mathematics in the gymnasium of Rakow. This school was founded by Polish unitarians, but was attended by pupils of all creeds numbering up to 1000, and existed from 1602 to 1638. The writer of the present notice applies the English expression "up-to-date" to the contents of the book in relation to the times in which it was published. The paper is illustrated by reproductions of the title-page, a drawing of the pantograph, anticipating by three years the previous records of its discovery by Scheiner, and a diagram for the solution of trigonometric problems, as we should say in "modern" examination papers, "by drawing and measurement."

THE report of the departmental committee appointed by the Board of Agriculture and Fisheries to inquire into and report upon agricultural education in England and Wales has been published as a Blue-book (Cd. 4206). The committee of twelve included Lord Reay (chairman) and Profs. T. H. Middleton and William Somerville. All institutions in receipt of grants from the Board of Agriculture were invited to submit evidence, witnesses from numerous institutions not in receipt of such grants were examined, and witnesses also attended from county councils, agricultural and other associations, in addition to those from Government departments at home and in the colonies. The total number of persons attending to give evidence was 113. It is impossible in a note to deal fully with the conclusions and recommendations of the committee, but one result arrived at is that there is no doubt that, by a general adoption of scientific methods, an important development could be effected in every branch of agriculture and in the various rural industries subsidiary to it. It is urged that a complete system of technical agricultural education is the natural corollary to the vast sums spent on elementary education in the rural parts of the country. The committee is of opinion that it will be possible to build up in England and Wales, at no excessive cost and within a reasonable time, a system of scientific and practical agricultural education equal, if not superior, to that now existing in any other country.

THE Lancashire Education Committee maintains a flourishing agricultural department. We have received an illustrated account of the scheme of agricultural education which has been devised for the county and is carried out at the County Council Farm, Hutton, the County Council Agricultural School, Harris Institute, Preston, and in various parts of the county. The county farm consists of $157\frac{1}{2}$ acres, and in connection with it are permanent dairy and poultry schools, with a chemical and bacterial laboratory. Manurial, feeding, and other experiments are conducted at the farm. The object of the agricultural school at Preston is to prepare young men and women for the work of a farmer's life by instructing them in the principles which underlie farming operations, and demonstrating modern and scientific methods of agriculture. A county staff of lecturers in agriculture, horticulture, butter-making, cheese-making, and poultry keeping is, so far as practicable, placed at the disposal of local education committees, agricultural societies, and farmers' or horticultural associations. Numerous farmers' bulletins have been issued, advice is given to farmers with respect to farming operations and agricultural experiments, and analyses of manures, feeding stuffs, soils, waters, and dairy produce are made at low fees for the farmers of the county. In these and other directions the Lancashire Agricultural Department is doing much to encourage and develop scientific agriculture.

THE regulations (Cd. 4187) for technical schools, schools of art, and other forms of provision of education other than elementary in England and Wales for the year 1908–9 have been issued by the Board of Education. There are not many changes, and those introduced are in the direction of greater efficiency and more elasticity. The limit imposed in previous years to the number of hours of instruction which may be counted for the purposes of grant has been relaxed, a fact which will encourage local education authorities to plan prolonged and well-organised courses of evening instruction and help to remove a reproach that much of the work in evening classes has been scrappy, unrelated to local industries, and not part of a coordinated scheme. Greater encouragement than formerly is being given to vacation courses for teachers, and the sensible advice contained in the prefatory memorandum as to the necessity of securing due recreation for teachers during the progress of the holiday work deserves the careful study of the organisers of such courses. It is now laid down by the Board that there shall in future be a principal, or head teacher, in those institutions where in the past unrelated classes in charge of separate teachers, responsible only to the managers, have been held. The new regulation will, if the right type of head teacher is appointed, lead to a greatly improved state of things. Students will be able to receive much needed advice in planning suitable courses of study to assist them in their industrial pursuits, and the work of succeeding sessions will form part of a complete scheme. The changes as a whole are conceived in a broad spirit, and should assist to develop still further the excellent work which is being done in technical and other schools.

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## *SOCIETIES AND ACADEMIES.*

### LONDON.

Royal Society, May 7.—"A Tantalum Wave-detector, and its Application in Wireless Telegraphy and Telephony." By L. H. **Walter.** Communicated by Prof. J. A. Ewing, C.B., F.R.S.

It has hitherto not been possible to employ a metal in conjunction with mercury as a wave-detector which is spontaneously restored to the sensitive condition, without some artifice which assisted decoherence; much less has it been possible to use a noble metal for this purpose. The only metal that has been found usable is iron, and this latter is, owing to its tendency to rust, manifestly not adapted to stand prolonged use, besides being otherwise not satisfactory.

The author has found that the metal tantalum gives an effect with mercury which greatly exceeds that obtainable with iron, the sound being very loud and of a pure tone. The tantalum, in the form of a fine wire point, dips into a pool of mercury so that the point is only just immersed. An external applied potential difference of about 0·2 to 0·4 volt gives the best results, the tantalum point being connected to the negative terminal.

As now generally constructed, the device comprises a glass containing-vessel into which are sealed two platinum wires. One of these wires dips right into the mercury, and serves to make contact therewith, while the other has its end hammered out into a form of clip which is made to hold the tantalum point.

The level of the mercury is adjusted while the usual telephone receivers are connected to the detector, and this adjustment, when once properly carried out, during the filling process, renders all further adjustment unnecessary. The whole arrangement is hermetically sealed in the glass bulb, which may previously have been exhausted.

The detector has been tried at various wireless telegraph stations, and has shown that for not too weak signals the sound is several times louder than the same signals with the electrolytic detector, it being understood that the most suitable telephones for each type of detector are employed. At a distance of 450 miles from a ship station fitted with a 2-kilowatt plant the signals obtained on the electrolytic and the tantalum detectors were of about equal loudness, although in this case the telephones were not at all suited to the tantalum detector.

The device just described is rather sensitive to shaking, and so a second form of detector is described which, owing to its construction, is quite indifferent to vibration and even to shock. Experiments were afterwards made with numerous other metals, but no other case of an imperfect contact of this nature was observed; the behaviour of tantalum is apparently unique.

From the physical standpoint the chief interest lies in the fact that by a suitable choice of materials it has been possible to revert to the primitive simplicity of a metal point in contact with another metal, and yet all the attributes of a modern detector be retained.

### EDINBURGH.

Royal Society, July 7.—Prof. Crum Brown, F.R.S., in the chair.—The craniology of the aborigines of Tasmania: Sir William **Turner,** K.C.B. This race had become extinct in 1877, and of the eighty skulls which were known to be deposited in various museums of this country and the Continent, no less than ten were in Edinburgh. The main features of these dolichocephalic skulls were described in detail, the curious roof-shaped top and the thick orbital ridges specially being noted. A cast of the face which belonged to the University Anatomical Museum was shown. The woolly or frizzled hair which differentiated the Tasmanians from all neighbouring races had been described by several travellers. The question of the affinities of the race was very obscure. All attempts to find relationship with the indigenous races of the Malay Peninsula and islands, with the Polynesian races, or with the inhabitants of Australia or New Zealand, could not bear close inspection. When first discovered by European travellers, there could not have been more than 70,000 Tasmanians in an island almost as large as Ireland. Throughout their isolation there must have been in-breeding for centuries, leading to an accentuation of any peculiarities which might have arisen, and so giving to the race its own peculiarities.—Inversion temperatures and the form of the equation of state: Prof. W. **Peddie.** It was shown that a number of equations of state, all fairly satisfactory otherwise as representative of facts, lead to the conclusion that the inversion temperature of air decreases as the initial pressure rises, which is contrary to Olszewski's experiments. Also the discrepancy cannot be explained as due to difference of initial and final kinetic energies. Some other source of error has probably affected the results. Observations of the critical temperature and its variation with pressure might discriminate among various equations of state.—Magnetic quality in the most open cubic arrangement of molecular magnets: Prof. W. **Peddie.** It was found that such an arrangement, unlike the closest packed arrangement, cannot explain the magnetisation of magnetite, but presents analogies to the magnetic properties exhibited by pyrrhotine.—Energy accelerations and partition of energy: C. W. **Follett.** From this discussion it appears that equipartition is not possible amongst the freedoms in some of the cases.—Combustion analysis: Prof. J. **Walker** and T. **Blackadder.** The paper described certain modifications of Liebig's method, which enabled the experimenter to use a smaller combustion tube and to carry through the operations in much shorter time and with less expenditure of gas.

### PARIS.

Academy of Sciences, July 27.—M. Bouquet de la Grye in the chair.—The necessity of making use of the three dimensions in space for the successive directions of the two moving right lines joining the sun and a planet to the earth, for determining in a simple manner the relative variations of magnitudes of these lines: J. **Boussinesq.**—The total sugar of the blood: R. **Lépine** and M. **Boulud.** It has been stated by MM. Hugounenq and Morel that larger amounts of sugar are found after hydrolysis with hydrofluoric acid than with sulphuric or hydrochloric acids, and they regard this as being due to the less destructive action of the hydrofluoric acid. The authors of the present paper confirm this fully, and have applied this reagent to the determination of the virtual sugar in the blood. Details of the technique are given, and it is shown that the amounts of sugar obtained by hydrolysis of the blood clot with hydrofluoric acid are of the same order as those obtained from the serum, the sum of the two representing the total sugar of the blood.—

The apparent dispersion of light in interstellar space and the hypothesis of M. Lebedew: J. **Stein.** A discussion of the theory put forward by M. Lebedew to explain the experimental results of Nordmann and Tikhoff. The theory would appear to be insufficient to explain all the phenomena observed with $\beta$ Aurigæ.—A new variable star with very short period discovered at the Observatory of Paris: Jules **Baillaud.** The existence of this star was noted from the photographic charts of P. and Pr. Henry, of 1900. The magnitude varies between 12·8 and 14·3, the passage from the maximum to the minimum taking about 1 hour 41 minutes.—A left-handed circular sextic: M. **Stuyvaert.**—The name of Fleurieu in geography: M. **de Fleurieu.**—A comparison of the different modes of action of imperfect contacts with variation of resistance and thermoelectric contacts as detectors of electric oscillations: C. **Tissot.** Replying to the criticisms of M. Branly, the author points out an essential difference between the detectors working by imperfect resistance and those depending on thermoelectric power; the latter require no auxiliary electromotive force in the form of a battery.—The ultra-violet spectrum of silicon: A. **de Gramont** and C. **de Watteville.** A comparison of the wave-lengths and intensities of the line obtained in the spark spectrum and in the flame spectrum.—The magnetic susceptibility of solutions: P. **Pascal.** The author finds that whenever an aqueous solution of a metal ion of a salt changes with its valency into a complex ion or into a colloidal compound, there is a diminution of the magnetic or diamagnetic properties superadded to the diamagnetism of the water by the simple metal ion. There may even be an inversion of the magnetic *rôle* of the metal on the solution. These phenomena are repeated when the complex ion passes over into a more complex ion.—The gases occluded in a special nickel steel: G. **Belloc.** The chief point of interest was the marked difference between the quantities of gas extracted from the same metal in the form of wire and turnings. The cause of the difference has not yet been ascertained.—A new method of estimating the fixed and volatile acids in wines: Emm. **Pozzi-Escot.**—The oxidation of isoeugenol. On dehydro-diisoeugenol: H. **Cousin** and H. **Hérissey.** By the oxidation of isoeugenol in alcoholic solution by ferric chloride, a substance having the composition $C_{20}H_{22}O_4$ is obtained. This corresponds to the formation of a double molecule following on the removal of two atoms of hydrogen by the oxidising agent. The properties of the new compound and the preparation of three of its esters are described.—A new method of preparing the mixed anhydrides of organic acids: J. **Bougault.** The method of preparation is peculiar in that the reaction takes place in aqueous solution and in presence of sodium carbonate. Phenylisocrotonic acid, treated with iodine in presence of a considerable excess of sodium carbonate, is converted quantitatively into benzoylacrylic acid. If the sodium salt of an aromatic acid is present during this reaction the mixed anhydride is precipitated. The mixed anhydrides of benzoylacrylic acid with benzoic, cinnamic, phenylacetic, and benzoylpropionic acids have been obtained in this way.—The constitution of vicianine: Gabriel **Bertrand** and G. **Weisweiller.** Vicianine is a glucoside obtained from the seeds of *Vicia angustifolia* and of several other species of the same genus. Under the hydrolysing action of diastases it gives hydrocyanic acid. In the present note vicianin is shown to resemble amygdalin in being a derivative of *l*-phenylglycollic nitrile.—The formation of jadeite in crystalline schists: Const. A. **Ktenas.**—Folotsy and Voharanga, two new Asclepiadeæ from Madagascar: MM. **Constantin** and **Bois.**—The formation of the conidia in the Aspergillaceæ: L. **Mangin.**—Contribution to the study of the serum of animals whose thyroid glands have been removed: L. **Launoy.** Poisonous properties have been attributed to the blood serum of animals the thyroid glands of which have been excised; the experiments of the author here given do not confirm this.—The influence of ferrocyanides and ferricyanides of the alkalis on the coagulation of the blood: J. Larguier **des Bancels.**—The diastatic hydrolysis of lactose, maltose, and their derivatives: H. **Bierry** and J. **Giaja.**—The inequality of the volume of the mammary glands in woman: the physiological consequences: G. **Variot** and P. **Lassablière.** In 550 cases, in only 24 per cent. was there equality in the size of the mammary glands; in 51 per cent. the left predominated, and in 25 per cent. the right. When the inequality is very pronounced the smaller gland appears to atrophy, and can only furnish a very small quantity of milk relatively to the other, and these variations in quantity are accompanied by changes in the composition of the mik.—The experimental study of the transmissibility of tuberculosis by dried sputum: G. **Kuss.** Petersson, Cadéac, and Calmette have emphatically denied the possibility of tuberculous infection by dried sputum, Cadéac affirming that the drying and loss of virulence go together. The author details fresh experiments made to settle this important point. It was found that when the conditions are favourable to desiccation tuberculous sputum dries readily in a few days, and was easily converted into dust, the virulence of which was proved by inoculation experiments. The inhalation of these powders caused tuberculous infection with extreme readiness, a result diametrically opposed to those of Calmette and Cadéac.—The kidney of the bony fishes: Louis **Roule** and L. **Audigé.**—Experimental researches on the adipose bodies of the Amphibia: R. **Robinson.**—The localisation of the sense of alimentary discrimination in the Limneæ: Henri **Piéron.**—The classification of the Tertiary strata of the Guelma region, Algeria: J. Dareste **de la Chavanne.**—The Calabrian earthquake of October 23, 1907: G. **Mercalli.**

## CONTENTS.

THURSDAY, AUGUST 13, 1908.

## GEOLOGICAL EXPLORATIONS IN SINAI.

*The Topography and Geology of the Peninsula of Sinai (Western Portion).* By T. Barron. Pp. 241; illustrated. (Cairo: National Printing Department, 1907.)

IN NATURE for September 19, 1907, we directed attention to the memoir by Dr. W. F. Hume on the topography and geology of south-eastern Sinai. We have now before us an account of the western portion of the peninsula by the late Mr. T. Barron, who was assisted in the topographical part of his work by Mr. S. T. Hardwick. This new volume does not compare in interest or lucidity with the previous one, but any defects must be dealt with gently when we bear in mind the transfer of Mr. Barron to the Sudan, and the termination of his promising career by death in that region. He has given us, at any rate, a detailed account of his observations on the topography and geology of western Sinai that will be useful enough to anyone visiting the ground, but otherwise difficult to follow. Thus, too few names are given on the geological map, and it is by no means easy to define the lines of geological section that are given in four folding plates.

The geological formations include gneiss and schists, great masses of red and grey granite, diorite, and Carboniferous Limestone and Sandstone, which together form the higher grounds of the interior. On the coast at Gebel Abu Darba there is a fringe of red granite bordered inland by Nubian Sandstone with overlying higher Cretaceous and Tertiary strata. As shown in one of the sections, this belt is separated from the main group of older strata in the interior by the plain of El Qâ, and further east by another tract of Cretaceous rocks, which are bent into a broad anticline with steep westerly inclination towards the plain, and faulted on the other side against the gneiss.

The plain of Qâ, described as a gravelly expanse, wind-swept and without shelter, is formed of a very mixed series of fluviatile, lucustrine, and marine deposits of Pleistocene and recent age, with a covering of igneous boulders from the hills and blown sand. Raised coral reefs and breccia border the greater part of the coast. Some of the sands of the plain are bound together with common salt and carbonate of lime.

The record of Pliocene strata is new. They consist of limestones with many pectens and echinids, and also teeth of *Carcharodon megalodon*, a form familiar to workers in the nodule-bed of the Suffolk Crag.

Particulars are given of the Eocene strata, with their nummulites, also of the Cretaceous divisions, and the author acknowledges his indebtedness to Mr. R. Bullen Newton for the determination of fossils from these and other strata. Some well-known European forms are recorded from the Carboniferous rocks, but, as is customary nowadays, the species are identified less confidently than in the earlier quoted lists.

The grey granite is regarded as one of the most valuable economic products, being suitable for statuary purposes. Iron and manganese ores are likewise of some importance. There are also turquoises, which, in the author's opinion, might be worked to more profit with improved methods of mining. He inclines to the view that they were formed by percolating water, the precipitate being afterwards subjected to enormous pressure. The gems occur in "pockets" in sandstone of Carboniferous age in a region that has been affected by considerable earth-movements, as evidenced by the faulting and folding.

A few remarks are made on the age of the rift of the Gulf of Suez, assigned by Neumayr and Blanckenhorn to the Middle Pliocene. The area of the gulf appears to have been a land surface in early Tertiary times, but at the close of the Oligocene or during the Lower Miocene it became depressed so as to form an arm of the Mediterranean—the Miocene fossils having affinities with the fauna of that sea and none with the Indian Ocean.

After subsequent elevation and denudation of the area, and towards the close of Upper Pliocene times, were formed the faults which bound the igneous and sedimentary ranges on either side of the gulf and the Isthmus of Suez. Subsidence then took place, and the Red Sea, which had by this time come into existence, invaded the depression. After this were produced the faults which bound the present gulf parallel to the older dislocations, and these are evidenced by raised beaches at different levels. The faults on the eastern side are somewhat older than those on the western side, as the series of beaches on the western side indicate a gradual rise after the actual fracture took place on the Sinai side. At the close of the Pliocene or beginning of Pleistocene time, submergence is again evidenced by various beach-deposits and by the brackish-water beds of El Qâ. In conclusion, the author points out that "although geologically the Gulf of Suez was in existence before the Red Sea, in point of age the fractures bounding the former are younger than those which produced the latter." H. B. W.

## A TREATISE ON AËRIAL FLIGHT.

*Aërodynamics: Constituting the First Volume of a Complete Work on Aërial Flight.* By F. W. Lanchester. (London: A. Constable and Co., Ltd., 1907.) Price 21s. net.

THE book before us is the first volume of a complete treatise on aërial flight, and is to be followed by a volume on "aërodonetics," a word coined by the author to denote the theory of the motion and equilibrium of bodies in the air. The author, by the way, is rather fond of coining new words; some of them—*aërofoil*, for example—are very happily chosen, and we hope that they may be adopted by subsequent writers on the subject. So far as mathematical theory is concerned, aërodynamics as applied to problems of flight does not differ from hydrodynamics, for with the small changes of pressure that accompany the motion of a flying machine, the compressibility of the air does not sensibly affect the motion. The first chapters, which deal with the theory of aërodynamics, are therefore a summary in non-mathematical language of the chief methods and results of hydrodynamical theory. They are, on the whole, very clearly written, and present in simple form all the most important points of the theory. The author is not, however, content to follow orthodox theory, but deviates from it in the treatment of several problems. Thus on p. 6 he introduces what he calls the "principle of no momentum," *i.e.* that no resultant momentum can be communicated to a fluid enclosed in a rigid boundary. Against the principle as stated no objection can be taken; but when, as on p. 16, it is applied to the motion of a body in an infinite fluid, it may easily lead to false results.

The second chapter contains an investigation on viscosity and skin friction. This has always been a subject of contention among writers on aërodynamics. Langley and Dines maintain that the tangential force on a plane moving sideways through the air is negligible, less than 0·01 per cent. of the force at normal incidence. Lilienthal, on the other hand, found the tangential force to be between 1 per cent. and 2 per cent. of the force at normal incidence, and therefore at small inclinations it may be comparable with the normal force. Mr. Lanchester, in the second chapter, brings some theoretical considerations to bear on the question, and proves that the force on a plane moving sideways varies as $v^{1\cdot5}$. This result is obtained by supposing the motion laminar, which seems to us quite unjustifiable. In chapter x. an account is given of experiments made on gliders to obtain a value for skin friction. The experiments appear to have been very carefully conducted, and considering the difficulties involved give remarkably consistent results. We hope that the author may be able to extend these experiments and so help to decide this question.

In chapter iv. the author leaves behind the solid ground of orthodox theory altogether, and attempts to work out the motion of a curved lamina or aërofoil. The importance of curved surfaces in flight was first realised by Philipps and Lilienthal. It seems to us that the author is wrong in claiming to be the first to give a theory of the motion of curved surfaces, and that Lilienthal had only a practical acquaintance with the curved form, for Lilienthal clearly realised that the effect of curvature was to diminish the eddy motion and to give an increased upward pressure due to the centrifugal force of the air. The theory has been worked out mathematically by Kutta, and his results are in fair agreement with Lilienthal's experiments. The author of the present volume attempts to work out the problem by applying the theory of cyclic motion to the motion of a surface in two dimensions, but it is difficult to see how this can have any application to the case of a lamina moving in free air. The next chapters contain discussion of various problems connected with flight; many of them are very interesting, but as they turn on the relative value of tangential and normal force, they are, in the present uncertainty as to these values, rather premature.

The last chapter contains an account of the experimental work of Dines and Langley. We could have wished that the author had extended this chapter to include the work of Continental writers such as Lilienthal, Wellner, von Lössl, &c., much of whose work is very valuable, and buried in technical journals which are inaccessible to English readers. Had he done this and excluded some of the more shaky theoretical chapters, the work might without exaggeration be called a complete treatise on aërodynamics.

## SPECTROSCOPY.

*Handbuch der Spectroscopie.* By H. Kayser. Vol. iv. Pp. xix+1248. (Leipzig: S. Hirzel, 1908.) Price 72 marks.

THE amount of material available on the general phenomena of absorption is well known to everyone who has interested himself in this branch of science, and it is impossible to withhold admiration for the manner in which the subject is treated in the present volume. It is not easy in a short notice to discuss in detail the merits or demerits of so varied a chapter of contents as we have before us, but a brief glance will serve to show the lines followed by the author.

Whereas in the latter portion of the third volume there was given a list of compounds of known constitution, together with their absorption spectra, the first three chapters of the present volume contain an account of the absorption of colouring matters as obtained from plant, human, and animal sources. Any possible criticism of the expediency of inserting these chapters is somewhat disarmed at the outset by Prof. Kayser's preface. He was himself somewhat doubtful at first, but concluded that it would be intolerable that a book on spectroscopy should pass over these most important substances in silence. At the same time, there is no doubt that much of the work that has been published on these colouring matters is worthless; indeed, these chapters serve to show how chaotic and uncoordinated are the results of investigators in these fields.

The fourth chapter, which is from the pen of Dr. A. Pfluger, deals with dispersion, or, rather, anomalous dispersion. Herein is to be found a fine critical review of the experimental and theoretical work on the relation between dispersion and absorption.

The next two chapters, which are each about 270 pages long, deal with phosphorescence and fluorescence, the latter being contributed by Dr. H. Konen. The division of the phenomena under the two heads is based upon the criterion that phosphorescence persists for a finite time after the exciting cause has been removed. The chapter on phosphorescence, commencing with an historical account of the subject, deals in succession with the various means of excitation and the experimental methods, the influence of temperature, the spectroscopic investigation of phosphorescence, and finally the theories of the underlying phenomena. This chapter contains a very full account of all the work which has been carried out, and will, indeed, prove very valuable. The literature is very scattered, and this is the first time that a reasoned attempt has been made to collect and correlate the somewhat discordant details of experimental research in the domain of phosphorescence.

Dr. Konen's chapter on fluorescence is again admirable, and is also prefaced with an historical section, from which may be gathered the interesting information that the first mention of fluorescence is an account which Robert Boyle found in a Spanish manuscript dated 1570 of an aqueous extract of some wood.

The second section of this chapter deals with the so-called bright-line fluorescence spectra, including, of course, the work on iodine and Prof. R. W. Wood's new work on sodium vapour. This opens the question as to what is meant by fluorescence, for it would seem that the phenomena of bright-line spectra obtained with iodine and sodium vapours are of a different order from the true fluorescence of organic compounds. Wood's more recent work would certainly go far to show that his results are those of optical resonance pure and simple. On the other hand, the real fluorescent phenomena of organic chemistry are of a very different nature. They are undoubtedly due to a certain complexity of structure; they undoubtedly require a linking together within the molecule of a definite number of centres of unsaturation (used in the chemical sense). Conversely, a simplification of the molecular structure tends to decrease the power to fluoresce. The two phenomena must therefore be of different type, and for this reason it would be preferable to treat the bright-line phenomena under a separate heading of resonance spectra, leaving the term fluorescence to the more complicated molecular phenomena of organic chemistry.

Following on the section upon bright-line fluorescence there are sections dealing with ordinary band fluorescence spectra, the method of investigation, the absorption and emission of fluorescing substances, the influence of temperature, of the solvent, and of the wave-length of the exciting light, and, finally, two sections dealing with the relation between fluorescence and chemical constitution, and also with general theories. A list of substances is added which are known to exhibit fluorescence, a list which, though far from complete, is a very useful addendum. This list brings to conclusion a volume which is a worthy follower of the three volumes which have preceded it.

## POPULAR ORNITHOLOGY.

(1) *A Bird Collector's Medley.* By E. C. Arnold. Pp. iv+144; with 12 coloured and 8 collotype plates and illustrations in the text. (London: West, Newman and Co., 1907.) Price 10s.

(2) *Birds of Britain.* By J. Lewis Bonhote. Pp. x+405; with 100 illustrations in colour. (London: Adam and Charles Black, 1907.) Price 20s. net.

(3) *A Book of Birds.* By W. P. Pycraft. Pp. viii+155; with 30 full-page coloured plates and illustrations in the text. (London: Sidney Appleton, 1908.) Price 6s. net.

(1) MR. ARNOLD has been known for several years past in the bird world as an enthusiastic shore-shooter who has been lucky enough in recent years to secure examples of several migratory birds which have very rarely been known to straggle to these shores, and, indeed, to add two species to the British list. He very ably justifies the killing of these rare migrants on the grounds that they are abnormal wanderers which would never settle in England, and adds that it seems far better that they should be carefully preserved for the benefit of those who would otherwise never see them rather than be observed through glasses by one individual for the space of perhaps half an hour at the outside. His introductory chapter is mainly taken up by a forcible defence of the amateur collector, who, he very truly says, is abused by books, periodicals, newspapers, and those very ladies who adorn their bonnets with stuffed terns and bullfinches. What is more contemptible is the attitude of "some eminent naturalist, who has possibly amassed a fine private collection in his youth, and has now taken up the fashionable cry." We were reminded of the truth of this "reprisal" upon reading quite recently a review of this very book. A chapter on bird-protection deserves careful perusal. It is an able summary of the whole matter, so far as it concerns this country, and contains more common-sense and less rubbish (we had almost written hypocrisy) than any other disquisition on the subject we have met with for a long time. For the rest, the book is chiefly an account of the author's personal experience as a field ornithologist and collector in many and varied parts of the British Islands, and contains many very interesting notes and observations.

One of the best chapters relates the experience of a dunlin, born on the fells, going down to the seashore for the winter and back to the moorlands in spring, and is very well told indeed (in the dunlin's own words). There is also a good chapter on bird-stuffing, and a medley was a good name for the book. The twenty full-page plates, the work of the author, portray some pleasing scenes in bird-life. Some also are intended to recall specimens of rare birds in the author's bird collection in the Eastbourne Institute. No one would wish to criticise their merits too closely; it is enough that for the most part they appeal to the emotions of the field ornithologist.

We must protest, however, against the plate of the two ruffs in full breeding dress fighting at their breeding grounds. Anyone who has watched ruffs on the "hill" must have been struck especially with one circumstance, viz. the great diversity in colour of the birds, and that from perhaps a dozen or so collected on the hill at one time it would be impossible to pick out two the colours and arrangement of colours of which were alike. We cannot, therefore, but regard the present picture displaying only two ruffs, and those practically as alike as two peas, as unnatural. For although such a case is not, of course, absolutely impossible, it is extremely unlikely. The various illustrations in the text are from photographs, and some of them, *e.g.* "Doing the Bushes," will recall days spent in that now famous spot to the minds of many birdmen. The addition of an index would have been an improvement to this nicely-got-up volume.

(2) Messrs. Adam and Charles Black have added to their series of beautiful books, with full-page illustrations in colour, a volume on "Birds of Britain." The

hundred illustrations are selected from Mr. Dresser's "Birds of Europe," and the originals, of course, are of the very best. But we can say very little for the reproductions. We see that the old faults of this kind of colour process have not, in this case at all events, been overcome. Here and there one of the colours used has asserted itself out of place or shown uncalled-for strength. On the curlew's plumage there appears a strange flush of carmine pink. This does not matter much to one who has known the curlew well for many years, and who knows that the colour is libellous. But how about "the genuine seeker after trustworthy information on British birds," who turns to the plate in order to find out how a curlew is coloured? Green, too, frequently shows itself when it is not wanted; and while colours have sometimes come out hard and crude, in other cases delicate tints have almost failed or played false, as in the legs of the reed-warbler, which do not agree in colour with the description. The barn owl is curiously blue, Richardson's skua green, and the dunlin, like several others, flushed with pink, while the head of the black-headed gull is much too bright and light a brown. Some plates are faint and indistinct.

Altogether we cannot regard this new colour book as a success. The plates have been selected so as to give examples of the most typical species. But if the book was to prove of help and service to the genuine seeker after trustworthy information on the subject, the selection might have been a more useful one. The commonest birds have not in every case been chosen, for the blue-headed appears instead of Ray's wagtail, and the mealy instead of the lesser redpoll; and it would have been better in the interests of the learner to carry this idea further, and to have illustrated some of the less common birds rather than well-known, conspicuous, and easily identified species. For instance, the blackbird, robin, goldfinch, bullfinch, chaffinch, starling, jackdaw, rook, skylark, kingfisher, kestrel, grouse, &c., might more usefully have been replaced by the woodlark, twite, siskin, brambling, grey shrike, woodchat, merlin, hobby, the harriers, shorelark, and some of the less conspicuously coloured waders and waterfowl. The guillemot in adult summer dress figured here is the variety known as the ringed guillemot. This should have been stated in order to avoid leading a beginner astray. The positions on the plate of the stormy and Leach's petrels are wrongly stated, and should be reversed.

The letter-press (which includes some account of every species of bird which has occurred in the British Islands) is of a popular character and very pleasantly written. The charming notes of the ways and habits of the birds have been taken at first hand, straight from nature, and are valuable and all the more interesting for that reason. But perhaps for this very reason they may seem sometimes to have been written from too limited a field of observation. At all events, if this were not rather a publisher's than an author's book, and more meant for the general public than for the naturalist, we might criticise some of the statements. To turn only to two species. With us the hedge-sparrow's song is certainly not commenced in March; nor do we think the missel-thrush is so very conservative in its choice of a nesting site, or that from four to *six* is the usual number of eggs laid by this bird; or, again, that the missel-thrush will be found sitting on a full clutch towards the end of February in Britain generally, though it may lay in that month in the south. To continue about the same bird; after the late Prof. Newton's observations, any doubt can hardly still exist about its "supposed" fondness for mistletoe berries. As no attempt has been made to husband space by condensing information or avoiding occasional discursiveness, the account given of each species is not so comprehensive as one might expect to find in this bulky volume, but all the birds are described, as well as the eggs and nests of all except the occasional visitors.

(3) The aim of Mr. Pycraft's book is to present the reader with a general survey of the principal groups of modern birds, such as are likely to be met with in zoological gardens or in museums. Of necessity many of the less-known species do not find a place here. In no single volume would it be possible to give anything like an intelligible description of the 14,000 different species of known birds. The reader, however, will find a concise account of some of the more important facts with regard to the life-history of the birds of Great Britain and of their European relatives, as well as of a number of the more remarkable birds of other lands. To give this in about 160 pages of rather large print was, even so, to attempt too much. Too much has been attempted in a small space. The treatment is very slight. Those who know absolutely nothing about birds will doubtless learn a good deal by studying these pages; and if the book wishes to claim the merit of displaying the bird-world at little more than a glance, why, certainly, a very long book was not required. Cheapness is a great merit in a book of this kind, but may perhaps be overdone. About 160 pages of letter-press on good thick paper, and thirty coloured plates, besides woodcuts, for six shillings is too much to expect, and something is likely to suffer. But if the plates make a critical ornithologist shudder, they will give the general reader a very fair idea of the birds they represent, and they are a marvel at the price.

## OUR BOOK SHELF.

*Handbook of Learned Societies and Institutions—America.* Pp. viii+592. (Washington, D.C.: The Carnegie Institution, 1908.)

To the Carnegie Institution a debt of gratitude is due for the preparation of a handbook of the learned societies and institutions of the world. The present volume is the first instalment, and deals with the societies of the western hemisphere, for it includes the United States, Canada, Mexico, the West Indies, Central and South America.

The supervision of the work was entrusted by the Carnegie trustees to the Librarian of Congress, and its organisation was placed in the hands of Mr. J. David Thompson, of the library staff, who has edited the volume, the material having been compiled by Mrs. Lucy C. Daniels Thompson and Miss Mary F. Griffin. Pending decision as to further publication, the remaining material relating to societies and institutions of the Old World will be kept on file available for consultation at the Library of Congress.

The names of the societies are placed in alphabetical order in various sections, the first containing the national societies of the United States, and the second, local societies and institutions; these together occupy 426 pages out of a total of 537. The volume contains twenty-four pages of addenda and corrections, and an excellent index of thirty pages.

Each entry commences with the official name of the society or institution, its postal address, and the name of the official, if any, to whom communications should be addressed. Notes of its history are given, including dates of foundation and incorporation and changes of name and organisation, and if it possesses a library the number of volumes is stated; its object; time and place of meeting; number of members and fees; the exact titles of its publications and any special publications; the mode of distribution of publications; and a statement of research funds and prizes.

It is a remarkable book, not only for its size, but for the large amount of information it contains and the evident care that has been taken in its preparation. It is to be regretted that the entries are not numbered, for it would be interesting to know how many associations there are in the New World; it would be too laborious to count the names in the book, but the first ninety-five pages contain those of no fewer than 125 national societies in the United States. The institutions are not all what would be usually considered as scientific societies, although, no doubt, the works that they perform are carried out in accordance with the scientific spirit.

The index is well arranged; the sciences are printed in capitals with references to the pages on which societies dealing with them are to be found; the full names of societies are in Roman, and those of publications which do not carry the names of the societies which publish them are printed in italics; it may not be generally known that many of the American journals are published by societies, and not by individuals and firms as is often done in this country.

The book is well printed, and cannot fail to be of great use to those interested in American societies and their work; its production reflects great credit on all concerned with its preparation and publication.

H. M.

*Supplementum Conspectus Florae Graecae.* Auctore E. de Halácsy. Pp. iv + 132. (Leipzig: W. Engelmann, 1908.) Price 6 marks.

THE publication of this supplement only four years after the completion of the main work shows once more how, far from exhausting the interest in the exploration of a country, a good flora rather acts as a most effective stimulus in widening and deepening it. As the main work was noticed in detail in this Journal (vol. lxxiv., p. 314), it may suffice here to state that the bulk of the supplement consists in additions of new localities, mostly from recent collections; but there is also a considerable access of species not recorded in the original "Conspectus," and of entirely new forms. The species referred to in one way or another amount to about 1600, certainly enough to justify the issue of a supplement. The disposition of one genus, Taraxacum, has been entirely recast after Handel-Mazzetti's new monograph. As it now stands, it comprises nine species against two in Boissier's "Floræ Orientalis," and five in the "Conspectus."

The treatment of nomenclature is commendably conservative; but why, then, the obsolete Wilckia for the well-known Malcolmia? One point, however, challenges criticism. In the original "Conspectus" we have already two systems of authors' quotations. In the body of the book we find, for instance, *Acantholimon echinus*, L.; in the index it is *Acantholimon echinus*, Bois. In the body of the supplement this species stands simply as *Acantholimon echinus*, whilst the index has it as *Acantholimon echinus* (L.); and many similar instances might be quoted. The correct citation is *Acantholimon echinus*, Boiss., or according to a now rather common fashion, *Acantholimon echinus* (L.), Boiss.

We hope there may be in four or five years' time another supplement with a general index to the whole work, including the supplements. This is very much needed, and it will give the author an opportunity of revising his citations according to a uniform plan, preferably that of the "Vienna rules." Then, we trust, will also disappear the rather numerous printers' errors which disfigure the index of the present supplement.

OTTO STAPF.

*Grundriss der Kristallographie für Studierende und zum Selbstunterricht.* By Gottlob Linck. Pp. vi + 256. Second edition. (Jena: Gustav Fischer, 1908.) Price 10 marks.

IN the preface to the first edition, published twelve years ago, Prof. Linck remarked that he wished to place in the hands of chemists and others to whom some knowledge of the properties of crystallised matter was necessary a book that should be moderate in cost and should discuss with sufficient fulness, yet in simple language, the elements of crystallography. Except for the alterations necessitated by the advances made in both the subject itself and the methods of teaching it during the interval that has elapsed, the second edition follows closely on the lines of the first. The thirty-two classes of possible crystalline symmetry are subdivided into six systems in the usual way, and the proper undertanding of the symmetry peculiar to each class has been much facilitated by the admirable illustrations, reproduced from photographs of wooden models, which have been introduced into this edition; the author now adopts Groth's nomenclature.

In the earlier edition, although Miller's notation was used as well as Naumann's, preference was given to the latter; the reverse is now the case, with consequent improvement in simplification. Space, too, has been saved, which has been utilised for a fuller discussion of the physical properties of crystals. More attention is paid to the relation between crystalline form and chemical composition, in connection with which so great an extension of knowledge has taken place during recent years. The utility of the book would have been vastly increased had a chapter or two been devoted to some simple methods for determining the morphological and optical constants of crystals.

The printing and general appearance of this edition are all that might be expected of the well-known Jena publisher.

G. F. H. S.

*A Hill Country: its Physical Features and their Significance.* By Russell F. Gwinnell. Pp. vi + 26; with geological map. (London: George Philip and Son, Ltd., 1908.) Price 1s. net.

MR. GWINNELL has prepared a contoured relief model of a district in the northern Clyde basin on which contours are taken at each 250 feet, and the vertical and horizontal scales are the same. The pamphlet is intended to be used with the model, and together they form a general illustration of those physical features which constitute what is known as scenery. The model and booklet should prove of real service to those teachers of geography who base their teaching as much as possible upon experiment and observation.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### On the Antiquity of Mummification in Egypt—A Correction.

In a recent article on the history of embalming, which was published in the *Cairo Scientific Journal*, I stated that a friend had told me there were two left hip-bones and no right in the remains of the so-called mummy of King Mykerinus in the British Museum.

I have just seen the skeleton, and I hasten to state that my information was not correct, and that there is no reason to suppose that all the bones did not belong to one individual.

At the same time, I must add that there is no conclusive evidence to show that the remains found by Colonel Vyse are either mummified or those of Mykerinus.

This question was raised by me in the course of a discussion on the antiquity of embalming. At the time of writing I had seen no genuine mummy earlier than those found at Sakkara in February, 1907, by Mr. J. E. Quibell. They were dated by him as belonging to the period of the tenth dynasty. Since then Prof. Flinders Petrie has directed my attention to a mummy which he found at Medum in 1892. It is assigned by him to the date of Sneferu, the last king of the third dynasty. Prof. Keith, the conservator of the Museum of the Royal College of Surgeons, where this body is now lodged, has allowed me to examine it. The body is certainly a properly embalmed mummy, and if Prof. Petrie's estimation of its age is correct—and it would be presumptuous of me to doubt it—then this specimen shifts back the date when mummification is known (*by positive evidence*) to have been practised in Egypt by nearly a thousand years.

August 7. G. ELLIOT SMITH.

### The Mechanics of the Inner Ear.

I am much indebted to Prof. McKendrick for his exceedingly fair review of my monograph on the mechanics of the inner ear (NATURE, June 4, p. 114). One point, however, seems to require a reply on my part. Prof. McKendrick suggests that I should make "a huge model" of the cochlea. I believe that it is of some general interest to state why I did not do this long ago.

One of the most important facts which the engineer has to keep constantly in mind is this, that one can but rarely increase or reduce the size of a machine by making all parts geometrically similar to the original. In most (especially hydraulic) machines a part of the function depends on volumes, a part on areas, and a part on lines. A linear increase in size of a hundred would involve an increase of all areas by ten thousand, and of all volumes by a million!

This principle applies, not only to engineering, but also to biology. Suppose I claimed to have made an artificial amœba. Prof. McKendrick surely would not deny my claim on the sole ground of my having failed to make one as large as a frog or a fish, if in all other respects it should be a perfect amœba. Unicellular organisms obviously cannot attain large sizes, because soon their surface functions become insufficient for their volume functions, and they have to obtain special organs for the former (*e.g.* gills).

In the present case, however, the principle is of a purely mechanical nature. The cochlea is a very tiny hydraulic machine, so tiny that its functional elements are microscopical. At the same time, its complexity exceeds that of any machine built by human hand. Any model would have to be a relatively huge model indeed. There are three reasons why I did not make any model:—(1) it is so improbable that in making a model I should hit upon proportions which enable the model to function that I would most certainly waste my time and energy; (2) if the huge model should (by a kind of miracle) happen to function in accordance with my theory, this would not prove that the cochlea functions likewise; (3) as soon as it would be known that the model did not function, some would undoubtedly conclude that therefore the cochlea cannot function thus either, although this conclusion is quite unjustifiable.

Only when, as the result of painstaking experimental, anatomical, and mathematical work, the theory has been greatly perfected will there be any hope of designing and then constructing a huge model which can be expected to function like the inner ear. MAX MEYER.

University of Missouri, Columbia, Mo., July 23.

I QUITE appreciate the force of Prof. Max Meyer's remarks. The point, however, is that while it would be impossible to make a model of a cochlea that would in all respects work like a cochlea, it would be interesting and instructive to make a large model on the principles so clearly set forth in Prof. Max Meyer's monograph, with the view of ascertaining whether a stroke of a piston (imitating the base of the stapes) would act on the whole length of a membrane (imitating the basilar membrane) or only on a portion of it.

A good many years ago I constructed a working model of the cochlea, founded on some suggestions by Prof. Crum Brown. This is described in Schäfer's "Text-book of Physiology," vol. ii., p. 1182, and the model is in the physiological laboratory of the University of Glasgow. It illustrated a possible method of analysis, but obvious objections may be urged against its mechanism. Prof. Crum Brown and I have often thought of making a larger and simpler model, and possibly in the leisure we now enjoy we may return to the subject. I would still recommend Prof. Max Meyer to try his hand on a model and put his views to an experimental test. JOHN G. MCKENDRICK.

### Elementary Organic Chemistry?

MAY I be permitted to direct attention to a question asked in a recent examination in organic chemistry for medical students, the syllabus for which states that "the whole subject is to be treated in an elementary manner"?

The question was:—"On analysis an acid whose melting point was 190° C. gave the following results, 0·2159 gram gave 0·3595 $CO_2$ and 0·1209 $H_2O$.

"On titrating with ammonia (1 c.c.=0·00334 $NH_3$), 0·4859 gram of the acid required 37·52 c.c.

"From these data calculate the molecular formula of the acid."

Assuming that by the term molecular formula structural formula is meant—else why is the melting point given?—and assuming that the acid does not contain nitrogen, the empirical formula $C_5H_8O_4$ agrees well with the data given.

Of the many dibasic acids of this formula, no one melts at 190°, the nearest being dimethylmalonic acid, which melts at 192°.

But apart from any slight error of this kind, is it to be expected that candidates, in a subject which is to be treated in an elementary manner (or, so far as that goes, in any manner whatever) and who may not consult books of reference during the examination, should be required to know the melting points of all the dibasic acids?

J. F. THORPE.

The University, Manchester, July 29.

### Space and Number.

IN relation to the ideas of Mr. Leonard J. Russell (NATURE, July 30, p. 305), it may perhaps be interesting to some of your readers to know that Leibnitz entertained analogous opinions upon the same subject. I quote from Baumann, "Die Lehren von Raum, Zeit und Mathematik," Berlin, Reimer, 1869, ii., p. 79:—

"Die Aufdehnung vorstellen wie ein Absolutes, entspringt daraus als seiner Quelle, dass wir den Raum vorstellen nach Art einer Substanz, obgleich er ebensowenig eine Substanz ist wie die Zeit. Darum haben die Scholastiker einst mit Recht den Raum ohne Dinge imaginär genannt, wie die Zahl ist ohne gezähltes Ding." See my book, "Spazio e tempo," Torino, Bocca, 1908, p. 177. OTTAVIO ZANOTTI BIANCO.

Via della Rocca 28, Torino, August 3.

## THE GROUSE-DISEASE REPORT.

WE are indebted to the secretary for an advance copy of an interim report, issued by the Board of Agriculture and Fisheries for Scotland, of the Committee on the Grouse-disease Inquiry appointed in 1905, with Lord Lovat as chairman. It should be stated at starting that although this committee was appointed by Lord Onslow, no Government funds were allocated for its use, in consequence of which the entire expense has hitherto been defrayed by private subscriptions, of which a list is given in the document before us.

From one point of view, the committee has been decidedly unlucky in that during the period of its investigations no cases of the acute, or epidemic, phase of grouse-disease have come under its notice. In these circumstances, to say nothing of further investigations required in connection with the chronic, or endemic, phase, the work accomplished cannot be regarded as in any way approaching finality. Nevertheless, the committee (and we think rightly) decided to issue the interim report now before them, if only for the purpose of informing subscribers what has been already done, to point out the lines of future investigations, and, above all, to endeavour to obtain additional funds, without which the inquiry cannot be much further continued.

As pointed out in a covering letter from the secretary, there is naturally considerable difficulty in issuing a very instructive report in the middle of an inquiry. Many important questions are still under investigation, and even where apparently definite results have been obtained, it has been deemed undesirable to publish these until they have been fully verified. Nevertheless, there is a wealth of most important and valuable information in the document, and the committee is to be congratulated on having apparently identified the cause and nature of the chronic phase of the disease. In the course of the inquiry reports have been drawn up dealing with bacteriology, the causes of mortality in specimens submitted for examination, the economic value of the grouse-shootings in Great Britain, and heather-burning. These and other reports are held over for the present, but will form part of the final report of the committee.

Although great caution is displayed in giving any statement as final, it is pointed out in connection with the chronic disease that it appears to be a wasting, and usually fatal, illness, in which the parasitic intestinal worms affecting grouse at all ages and all seasons attain, probably owing to lowered vitality on the part of their hosts, an abnormal development, and are thus enabled to react injuriously on the bird's general health and condition. The most easily recognised symptoms are loss of weight, redness and acute congestion of the interior of the long blind-appendages (cæca) of the intestine, and an irregular moult and slow subsequent re-feathering, resulting in bare legs and a poor and dingy condition of the plumage.

The latter features, as pointed out by Mr. E. A. Wilson, the field-naturalist to the committee, in a separate section of the report, must not, however, by any means be regarded as absolutely diagnostic of the disease. They may, and frequently do, occur in a bird the moult of which has been delayed, and the recovery of which from the effects thereof has been slow. Such birds display the same appearance of dusky, faded plumage and bare legs and toes common to the majority at an earlier stage of the season (when they do not come under the ken of sportsmen), and likewise to birds afflicted with the disease.

In the earlier stages the grouse is less strong on the wing than ordinarily, and changes its station from the heather to the green ground; in many cases the feathers lose their freshness, while a tape-worm may frequently be seen hanging from the vent as the bird rises. In the later stages the power of flight is lost, the congestion of the intestine becomes still more acute, tape-worms are frequently expelled without the slightest beneficial effect, while both blind-appendages absolutely swarm with microscopic thread-worms. Loss of weight makes itself daily more noticeable, and the bird mopes about the banks of the stream until death puts a term to its sufferings.

The tape-worms have, apparently, nothing to do with the disease, being expelled merely on account of the abnormally irritable condition of the intestines. The real offender seems apparently to be the thread-worm, *Trichostrongylus pergracilis*, with which, as already mentioned, the inflamed cæcal appendages are crowded. This provisional conclusion is supported by the fact that while in other animals tape-worms do not generally give rise to fatal diseases, thread-worms certainly do so, as in the case of the miner's worm.

The report next takes into consideration the epidemic or acute phase of the disease, which, as mentioned above, the experts of the committee have hitherto had no opportunity of examining. It is true, indeed, that birds in full plumage and of normal weight have been sent in as examples of mortality due to the acute phase, but these, on examination, proved to have died either from the ordinary wasting disease or from the effects of accident.

The external signs of this disease are stated to be that the birds succumb rapidly, without loss of weight or deterioration of plumage, while the local action of the disease is reported in many cases to be intense. *Post-mortem* examination is stated to reveal patchy congestion of one or both lungs, comparable to the "hepatisation" of tissue occurring in undoubted pneumonia. The internal organs generally are also stated to be congested, and to exhibit other symptoms of acute and rapidly fatal fever.

By Prof. Klein this phase of grouse-disease was considered to be an acute form of infectious pneumonia, due to the presence of parasitic organisms probably belonging to the "colon" group, these being chiefly found in the lungs of infected birds, although, at any rate after death, they might occur in other organs.

The committee, without wishing to undervalue the evidence of a specialist of Klein's reputation, or the testimony of naturalists and keepers generally, remarks :—

"Klein's organism belonged to the widely distributed colon group, and, according to the limited cultural and morphological tests then used, differed in no way from other organisms of the colon group found in the grouse.

"Members of the colon group, apparently culturally and morphologically identical with Klein's organism, can be isolated from the heart, blood, lungs, and liver of both healthy and emaciated grouse that have been dead for a period of from twelve to twenty-four hours, the actual time varying with such factors as temperature and moisture.

"With regard to keepers' evidence and statements that birds die in full weight and plumage, it must be placed on record that already several times during this inquiry the acute form of grouse-disease with full-feathered birds of good weight has been reported, but in each case examination by the committee's experts has shown that the bird died only from the wasting disease, or as the result of accident.

"While it is not argued from the above that only one form of disease exists, it is, however, a fact not without significance that in the years 1905, 1906, and 1907 no instance of the acute pneumonic form of grouse-disease has come to the notice of the committee, though that committee has had field-observers, 283 local correspondents, as well as keepers on the large majority of the more important moors constantly on the look-out for it."

In his own portion of the report Mr. Wilson observes that a condition similar to that supposed to be diagnostic of the acute form of the disease may be found in almost any grouse picked up dead upon the moors. Prof. Klein described and figured preparations of the lungs of grouse supposed to have died from the acute phase of the disease, in which the vessels are absolutely plugged by bacteria.

"Without doubt," writes Mr. Wilson, the observer "finds in his microscopic sections of similar lungs similar conditions, presumably of similar disease. But to the experienced bacteriologist a doubt occurs whether these plugs of bacteria in the vessels of the lung should not be considered *post-mortem* instead of *ante-mortem* productions; the result of *post-mortem* changes allied to decomposition, rather than to pathological changes due to disease in life. Following this comes another doubt, whether the more gross appearances of disease in the lungs on dissection are not really due to *post-mortem* changes rather than to disease in life. And upon examination of presumably healthy birds after a lesser or greater prolongation of *post-mortem* putrefaction and delay, suspiciously similar appearances in the lungs are certainly observed."

Again, experiment has shown that in a healthy pigeon killed by chloroform the appearances to the naked eye supposed to be characteristic of the acute grouse-disease make themselves noticeable in the lungs after a period sufficient to permit the development of *post-mortem* changes.

Reading between the lines, it seems to us apparent that the experts of the committee are very sceptical whether, in the first place, the acute phase of the disease really exists, and, in the second, if it be existent, whether it is of a pneumonic character. They do not, however, apparently "like to bet till they know."

To revert to the chronic phase, its place of origin and mode of dispersal are points to which special attention has been directed by the committee, but considerable difficulties have been experienced in these respects owing to the very natural reluctance of owners and keepers to report the occurrence of disease unless it is widely spread in their district.

One fact the committee considers to have been indisputably established, namely, the intimate connection existing between the food-supply and the health of the grouse, or, in other words, the fact that the capacity of the birds to resist the attacks of the intestinal worms depends mainly upon their physical condition and general fitness. Owners and keepers have for years been convinced of cycles of maximum and minimum development of grouse-disease. Records from various estates extending over a period of more than half a century indicate that the cycle comprises a good year, a very good year, the record year, the bad year, the recovery year, the average, and the good average year.

A regular sequence of events, culminating in an over-stock, a consequent shortage of food, the appearance of disease, and a sweeping of the moor, occurs in the rare cases where disease follows a bad year. Examination will, however, often show either that in such cases the effect of a previous outbreak had not passed away, or that exceptional conditions had reduced the food-yield of the moor to less than usual. Again, the exceptional occurrence of several consecutive good years may be attributed to a better heather-crop, through improved management, or to open winters or early springs which have allowed a larger stock of birds to be maintained.

The theory that disease is due to the consumption of frosted-heather is refuted by the fact that heather in this condition is never eaten by grouse. Investigation has shown that grouse have to do all they know in the way of eating in order to maintain themselves in condition, especially in winter and spring; consequently any food-shortage at the two latter seasons is bound to result in ill-effects. Further, it has been observed that the mortality among hen-birds is most noticeable in late summer, perhaps induced by shortage of food during the nesting-season.

As regards remedial measures, nothing really definite can be suggested until much deeper investigation has been made into the life-history of the grouse thread-worm—investigations to which Mr. Shipley is devoting his best attention.

As contributory measures to the checking of the disease, attention is, however, directed to the importance of proper estate-management, in the matter of heather-burning, the supply of grit of proper quality for the birds to eat, the draining of the ground, and last, but not least, the killing off of weakly birds—"cheapers"—which cannot but give rise to a poor and ill-nourished progeny.

In conclusion, we desire to offer to the committee and the experts by whom they are assisted, our congratulations as to the admirable and exhaustive manner in which this very difficult inquiry and investigation has thus far been conducted.

R. L.

## THE INTERNATIONAL GEOGRAPHICAL CONGRESS AT GENEVA.

THE ninth International Geographical Congress was opened at Geneva on July 27, and the business portion of the proceedings came to an end on August 6. It is only possible here to give a brief sketch of the subjects discussed and resolutions adopted.

As regards the general intention and meaning of the congress, it may be assumed that that somewhat vague word geography is usually taken to denote a group of studies connected with the influence of the surface features of the earth on the human race. But, if the proceedings of the congress may be taken as a guide, this aspect of geography has no very full recognition. By far the most prominent discussions and papers were those dealing with mathematical geography, cartography and allied subjects, and those treating of physical geography. The latter subject was chiefly in the hands of the geologists; indeed, it is hard to imagine anyone but a geologist doing useful work in this field. It might almost be said that geography, in the opinion of the average geographer, as deduced from the proceedings of the International Congress, is mainly the concern of surveyors and geologists. Geography in this sense is earth-knowledge; its chief function is to determine and explain the shape of the earth, the positions, forms, and characters of its surface features, and, so far as may be, to predict future surface changes.

Of the 232 papers of which the programme was composed, 124 dealt with physical geography, survey, exploration, and kindred subjects; 11 with rules and nomenclature; 14 with the teaching of geography. Meteorology accounted for 15, biology for 10, anthropology for 14, historical geography for 15, and economic and social geography for 26. The sectional meetings in some of the last-mentioned subjects were not well attended.

At the opening session a paper of considerable historical interest, entitled the "Circumnavigation of Africa under Necho II.," was read by M. A. Moret, of the Musée Guimet. According to Herodotus, it was Necho II. who caused certain Phœnicians to undertake this journey, which lasted three years. The successors of Herodotus denied that Africa was surrounded by water, and the world remained ignorant of the truth of the case until the time of Vasco da Gama.

M. Moret described how he found a scarab inscribed with hieroglyphics amongst the objects left by the will of the late M. Burian, the Egyptologist, to the Musée Guimet. The inscription relates the return of the navigator Pa-du-Neit to Bubastis. This account is corroborated and completed by an inscription on another scarab in Brussels; this latter scarab also originally belonged to Burian's collection. The second inscription states that the explorer took one year and seven months to reach the Cape (of Good Hope?), that the entire journey lasted four years, and that Necho caused the details of the voyage to be engraved on a stele in the temple at Bubastis.

In the discussion which followed the reading of this paper, M. Naville expressed his belief in the authenticity of the scarabs. Prof. Oberhummer, however, pointed out the necessity of caution in accepting evidence of this character, and threw some doubts on the genuineness of the scarabs. The net result is that the layman is left very much where he was before, and it would appear that even if the scarabs be accepted as genuine, the accounts are too vague to indicate any high degree of probability that the supposed circumnavigation was accomplished at that early date.

Early in the proceedings of the congress a discussion was originated by M. Lecointe, director of the Royal Observatory of Belgium, on the subject of the organisation of an International Polar Institute. It appears that such an institute was founded at Uccle in 1907 by private enterprise, that it is strongly supported by the Belgian Government, and that it is intended eventually to instal the offices and library of the institute in Brussels.

At present the institute does not, perhaps, deserve the appellation "International." Its staff is essentially Belgian. It should be mentioned, however, that the scheme has the support of the Duke of the Abruzzi, of Captain Cagni, and of Mr. Nordenskjold.

The intentions and objects of the Institute, as set forth in the prospectus circulated at the Congress, are:—(1) the formation of a special library, (2) the collection of maps and photographs, (3) the compilation of a bibliography, (4) the organisation of an encyclopædia, (5) the publication of an International Polar Review, and (6) the formation of a museum.

Now, although such an establishment would be instructive, and would, no doubt, have an educational value, it is extremely doubtful whether it would, in the present state of knowledge, be of any real practical service in assisting the work of polar exploration. For instance, would an intending British explorer study at the Brussels Institute when there is so much more first-hand information available in London? Is the existing information which we possess about the polar regions so voluminous as to require special and formidable apparatus of the character above described? These considerations prevented the British delegates from supporting the scheme, although they did not actively oppose it. Its ultimate failure or success will largely depend on the attitude of the principal geographical societies.

At the second general sitting of the congress, Prof. Penck read a report on the state of advancement of the general map of the world on the scale of 1 : 1,000,000. This scale was recommended by the London congress of 1895. Series of maps on this scale have been published by the British War Office, by the French Service Géographique de l'Armée, and by the German Landesaufnahme. The United States Geological Survey is about to publish maps on the same scale, and General Schokalsky announced that the Russian geographical service was about to do the same.

A very practical proposition was made by Prof. Davis on behalf of Mr. Gannett, of the United States Geological Survey, that a committee should be appointed to recommend a uniform system of symbols and conventional signs. This proposal was warmly supported by the British delegates, who made the additional proposal that each Government or map-producing office should be asked to supply within twelve months specimens of maps on this scale to form a basis for discussion.

A temporary committee composed of one representative each of Great Britain, France, Germany, Russia, and the United States was appointed. The committee met without delay, and drew up a series of resolutions defining generally the character, symbols, and conventional signs of the map in question. These resolutions were printed and submitted to a general meeting of the congress, and were approved. They will now be brought to the notice of the various Governments concerned, and it is hoped that these Governments will appoint an official international committee to draw up detailed rules.

As was to have been expected, a good deal of time was devoted to the discussion of the history, structure, and action of glaciers. Prof. Penck gave an address on the climate of the Alps in the Glacial period. He pointed out that although the glaciers descended to a low level, there was in the centre of the Alps a region entirely free from ice. The extension of the glaciers may be considered as due to a diminution of temperature of a few degrees only. M. Chodat supported Prof. Penck's theories from the botanist's point of view.

Prof. Brunhes dealt with glacial erosion. He described the difference between glacial valleys of a U form with a stepped longitudinal section, and those of the V form of regular longitudinal slope.

M. Raoul Gautier directed attention to the correspondence between the oscillations of glaciers during the nineteenth century and temperature observations at the St. Bernard. Several speakers pointed out the importance of the erosive action of the glacial streams. M. Jacob described the glacial research carried out in Dauphiné under the direction and at the cost of the Ministry of Agriculture; and there were many other communications on the same subject.

Glacial literature and discussion appear to be growing at a somewhat alarming rate. A summary, in English, by a competent writer, of modern investigations and theories would be useful.

There is no space here to describe, even in outline, the discussions in the borderlands known as historical geography, biological geography, and ethnographic geography. As regards meteorology, few of the communications had any strictly geographical bearing, and the greater number were more suited for discussion at a meteorological congress.

The arrangements of the congress were satisfactory as regards the halls and lecture-rooms, which were lent by the University, to which body the delegates owe their thanks. But in one important respect the organisation was defective. No summaries of papers were published in advance, and it was difficult to discover in advance anything about the character of the communications. It is much to be hoped that at the next congress, which will be held in

Rome in 1911, the following points may be attended to:—(1) The working session should be limited to one week; (2) only papers of serious scientific value should be accepted; (3) summaries of all such papers should be distributed (in the four authorised languages) on the opening day.

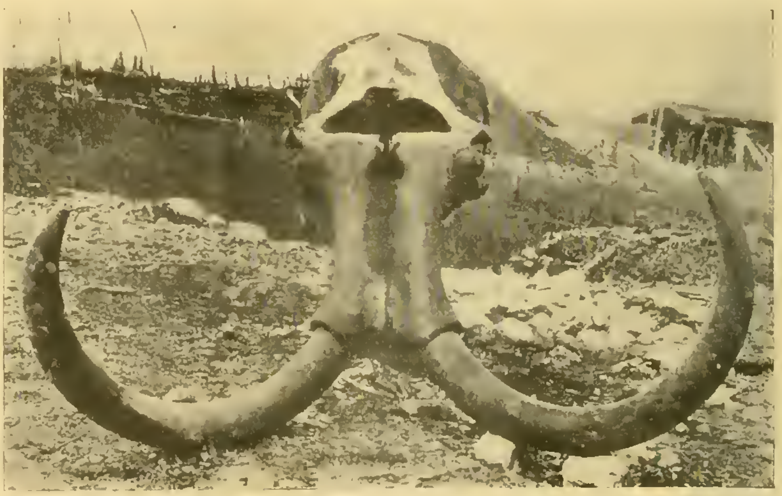
On the social side the delegates have every reason to thank the Federal and Cantonal authorities, the organising committee, and the Swiss members of the congress for their charming hospitality.

As to the outcome of the congress, the principal concrete result is the step taken towards the standardisation of the 1 : 1,000,000 map. But in all such meetings the obvious results are by no means the only ones to consider. It is no small gain that men of many nationalities, interested in a particular group of studies, should meet together to exchange ideas and experiences. One cannot doubt that such meetings have a value in broadening human knowledge and sympathies which is not to be measured in any simple quantitative way. As the president of the Swiss Confederation said, in words which it would be difficult to improve, "Votre Congrès contribuera au rapprochement des nations et à la fraternité entre les peuples, car rien n'est plus propre à dissiper les divergences de vues et à élever le regard au-dessus des bornes-frontières de chaque pays que la connaissance des lois universelles qui régissent le monde et unissent d'un lien naturel la grande famille humaine."

C. F. CLOSE.

## MAMMOTH-HUNTING IN ALASKA.

SINCE Kotzebue's discovery of fossil remains of mammoth and musk-ox in 1815, Alaska has been famed as a store-house for Pleistocene mammals; and in 1904 the Smithsonian Institution dispatched an expedition to obtain specimens for the museum at Washington. This expedition also visited Yukon territory, where it was successful in obtaining the magnificent mammoth skull shown in the accompanying illustration. Last year a second fossil-hunting expedition was dispatched by the same body, in charge of Mr. C. W. Gilmore, the results of which are recorded in vol. li. of Smithsonian Miscellaneous Collections. Mammoth-tusks of very large size were seen and measured, although it does not appear that the finest were transported to Washington. Incidentally, it is mentioned that the largest known skeleton of the mammoth is in the museum of the Chicago Academy, and is stated to be 13 feet in height. If this be true, reconsideration of the opinion that the mammoth was an animal of the approximate size of the Indian elephant is apparently demanded. Reports have been current to the effect that remains of the American mastodon occur in the Alaskan mud in company with those of mammoth. This, however, is an error, such remains being found in this region only in the "placer" deposits of the Yukon, which are doubtless of somewhat earlier age. The other remains discovered by the expedition include those of bison, elk, horse, beaver, and bear. The bison-skulls, some of which retain the sheaths of the horns, are referred to two distinct species, and indicate animals with an enormous horn-spread, altogether unparalleled by their modern representative. Alaskan mammoth-ivory is stated to be, on the average, inferior in quality to that from Siberia.



Skull and tusks of *Elephas primigenius* found 42 feet below the surface, in the muck, on Quartz Creek, near Dawson, Yukon Territory, Canada.

## ALPHONSE PÉRON.

IT is with deep regret that we record the death of Alphonse Péron, eminent geologist and soldier, who passed away at Auxerre on July 2, after a lingering illness.

Pierre Alphonse Péron was born at Saint Fargeau on November 29, 1834, and studied at the college of Auxerre, where his lively interest in natural history soon became manifest. At the age of nineteen he entered Saint Cyr, whence he passed into the infantry in January, 1855. He served in various districts in France and in Corsica, was engaged in Algeria in the suppression of the rebellion of 1864, obtained his captaincy in 1867, and in the Franco-Prussian war served with the army of the Rhine. At Sedan he was severely wounded and left for dead upon the field. He retired from the army in 1896, having received the honour of Commandeur de la Légion d'Honneur in 1890.

Notwithstanding the exacting nature of his military duties, Péron neglected no opportunity for the indulgence of his taste for geology. Wherever he went he never failed to note the geological characters of the district, and, when possible, to make a collection of fossils. His observations in the field provided a considerable number of memoirs and notes which have appeared in the Memoirs and Bulletins of the Geological Society of France, of which society he was elected president in 1905; in the *Comptes rendus* de l'Académie des Sciences, in the *Comptes rendus* de l'Association française pour l'Avancement des Sciences, and other serials. The Société des Sciences historiques et naturelles de l'Yonne, in which he took great interest and ably supported his friend Cotteau, owes much of its success to his energy; in the Bulletin of this society are to be found some important papers from his pen. Among Péron's principal contributions to geological science since the appearance of his first work, "Notice sur la Géologie du Canton de Saint Fargeau," published in 1865, may be mentioned "Notes pour Servir à l'Histoire du Terrain de Craie dans le S.E. du Bassin Anglo-Parisien." To his sojourn in northern Africa we owe the numerous works on the geology of that region, and one of them, the "Essai d'une Description géologique de l'Algérie," was awarded the Grand Prix des Sciences physiques. A most important work on "Les Ammonites du Crétacé supérieur de l'Algérie," was published in the Memoirs of the Geological Society of France in 1896–7. He also made a special study of the stratigraphy of the Cretaceous rocks of France and Belgium.

Péron was a correspondant of the Academy of Sciences. In him geology loses one of its most conscientious and disinterested students, one who, while honours were showered upon him, found his greatest delight in assisting his younger *confrères* in the elucidation of some difficult problem in stratigraphy.

## NOTES.

A Royal Commission has been appointed by the King to make an inventory of the ancient and historical monuments and constructions connected with or illustrative of the contemporary culture, civilisation, and conditions of life of the people in Wales from the earliest times, and to specify those which seem most worthy of preservation. The commissioners are:—Sir John Rhys, University of Oxford; Prof. E. Anwyl, University College of Wales, Aberystwyth; Prof. R. C. Bosanquet, University of Liverpool; Mr. E. Vincent Evans; Alderman Robert Hughes, J.P.; Rev. Griffith Hartwell Jones; and Lieut.-Colonel W. Llewelyn Morgan, R.E. The secretary is Mr. Edward Owen, of the India Office, S.W., and the assistant secretary Mr. P. E. Thomas. We warmly congratulate Wales. We presume there are no ancient monuments in the other parts of Britain.

We regret to learn that Prof. Kamerlingh Onnes's account of his researches on the liquefaction of helium is delayed by illness brought on by overwork. We hope, however, to be able to print an authoritative description of the investigations shortly.

We learn from *Science* that by a recent decree of the Government of Peru, issued by President Pardo, the time of the seventy-fifth meridian west of Greenwich was on July 28 adopted as the national standard time for the whole of Peru. The meridian is only a few minutes from that of Lima, and runs almost exactly through the middle of the country. All timepieces throughout Peru will now coincide with those in the United States where eastern time is kept. Peru is the first South American republic to adopt the world standard.

It is proposed to publish reproductions of the collection of 338 portraits of living physicists presented recently in an album to Prof. von Lang, Vienna, in celebration of his jubilee, if a sufficient number of subscribers can be found. Intending subscribers should communicate with Prof. Anton Lampa, Vienna, IX. Türkenstrasse 3. Applications after the publication of the reproductions cannot be considered, as only so many copies will be made as are subscribed for.

We notice with regret that the committee of the Denmark Greenland Expedition has received a telegram announcing that Dr. Mylius Erichsen, the leader of the expedition, and two companions, a Dane and an Eskimo, have perished in a snowstorm while travelling inland. The general work of the expedition has, however, been successfully accomplished, and the whole north-eastern coast of Greenland has been charted. A Reuter message states also that Dr. Erichsen and his two companions who perished with him were driven on to an ice-floe during a snowstorm, and that they drifted away from land. Their provisions being exhausted, the explorers became so weak that they were unable to return to the station. The Eskimo who brought the news arrived in a dying condition, and died immediately after making his report. The expedition left Copenhagen on June 24, 1906, and its main object was to map the little-known parts of north-east Greenland and collect material for the study of ethnological, biological, and seismological questions in those regions.

The next meeting of the Australasian Association for the Advancement of Science, which will be held at Brisbane in January, 1909, provides an opportunity for the younger generation of scientific workers to bring the results of original work before an influential and interested audience in the Antipodes. At the meeting there will be gathered together most of the leading representatives of scientific and engineering societies of Australasia, and also men holding high administrative or consultative positions under the various governments. Papers from British contributors will be sure to receive marked attention, and the authors' names will be introduced to important people in a portion of the globe where competition for vacant posts is less keen than it is in Europe or the United States. Mr. K. Swanwick, honorary secretary of Section A (Astronomy, Mathematics, and Physics) of the association, asks us to say that original papers from the British Isles will be heartily welcomed in his section; for, in the absence of the large and well-equipped laboratories of the older countries, it is unlikely that such papers by local workers will be numerous. Communications should be sent to Mr. Swanwick at Celtic Chambers, George Street, Brisbane, as early as possible, and the final date for receiving papers is December 26, 1908.

On Saturday, August 8, Mr. W. Wright made a remarkable flight with his aëroplane at the Hunandières racecourse, Le Mans, in the presence of leading members of the Aéro Club of France. The aëroplane rose easily to a height of 30 feet or 40 feet, and travelled over a course of about 2500 feet in one minute forty-five seconds, returning within 50 feet from the point of departure under the complete control of the aëronaut. On Monday, August 10, Mr. Wright made his machine describe a figure of eight twice in the air, and then returned to the starting point without any difficulty. In another flight, on Tuesday, he described three wide circles at various altitudes. The flight lasted three minutes forty-three seconds, and the aëroplane travelled at a speed of 65 kilometres an hour.

Further particulars of the voyage of Count Zeppelin's airship on August 4, and its subsequent unfortunate destruction, can now be added to the information available when we went to press last week. It appears that the voyage from Friedrichshafen, which was left at 6.45 a.m., to Mannheim—a distance of about 360 kilometres—was accomplished in eight hours. When Count Zeppelin landed near Oppenheim about 6 p.m., the airship had been eleven hours continuously in the air, but the average speed for the whole voyage was reduced, owing to a defective motor, to 36 kilometres an hour. The return voyage from Mainz to Echterdingen, where Count Zeppelin landed on the morning of August 5—to await fresh supplies of hydrogen rendered necessary by leakages in the balloon—took eight hours, though the distance was only 200 kilometres. According to Reuter, at Echterdingen, a sudden violent thunderstorm breaking over the town struck the balloon at its moorings and blew one of the cars into the air. The car fell back, striking the ground, and a motor exploded, setting fire to the adjoining parts of the airship. Several soldiers helping to hold down the airship were dragged into the air with the ascending car, and severely injured by the explosion. The blazing airship was caught by the storm and driven up into the air, where it was completely destroyed, and the framework blown away by the storm. A *Times* correspondent states that the most probable explanation of the disaster appears to be that when the airship was torn from its moorings by the force of the sudden hurricane the machine was brought into violent collision with trees and other obstacles, with the result that the benzene exploded and set fire to the whole fabric. The German Government has sanctioned the payment to Count Zeppelin of the grant of 25,000*l.* voted to him by the Reichstag last spring as compensation for his many years of self-sacrificing creative work in the building of airships. A public subscription has been inaugurated in Germany, and is meeting with a liberal response. Public and private donations to the amount of about three million marks (50,000*l.*) have been promised already toward a great national testimonial to Count Zeppelin.

THE oyster-fishery in the Lim Fjord forms the subject of parts xv. and xvi. of the report of the Danish Biological Station for 1908. After a historical survey of the discovery of oysters and the development of the fishery in this locality, the author, Dr. C. G. J. Petersen, refers to the present unsatisfactory state of the trade, and makes certain suggestions as to the best means of improving it in the future. The most obvious method is by preventing the enormous wastage of "spat" which now takes place, and with this object in view it is suggested that the beds would show a much better yield if they were regularly dredged by Government, or were leased out to private owners on more favourable terms than at present.

IN a paper published in the *An. Mus. Nac. de Buenos Aires*, vol. xvii., on the structure of the scapular arch in edentates and monotremes, as affording evidence of the reptilian descent of those groups, Dr. F. Ameghino recalls that in 1893 Mr. Lydekker proposed a new scheme of nomenclature for the bones of this part of the skeleton in vertebrates. It was shown, for instance, that in dicynodonts there exist a coracoid and metacoracoid, of which the first is represented in edentates, while both occur in monotremes (where the first is generally miscalled epicoracoid and the second coracoid). It follows from this that the so-called coracoid of a bird and a lizard is a metacoracoid. Although Mr. Lydekker's views were strongly opposed at the time of their publication, Dr. Ameghino maintains that they are indisputably correct, and that the revised nomenclature of the bones should be adopted in anatomy.

A SECOND paper by Dr. Ameghino in vol. xvii. of the *Anales* of the Buenos Aires National Museum is devoted to the alleged occurrence of remains of armadillos in the Oligocene of France and Germany. In view of the opinions which have been advanced as to the reptilian nature of these remains (which consist mainly of the plates of the dermal head-shield), the author states that he can no longer definitely assert that they indicate the occurrence of armadillos in the European Oligocene. At the same time, he refers to a figure of the microscopic structure of one of these bony plates, published by Filhol, which accords very closely with similar figures of armadillo plates, and differs markedly from the structure presented by the plates of certain lizards. To settle the question, it is urged that sections of the plates of the so-called Necrodasypus should be compared with those of the dermal armour of the approximately contemporaneous lizard Placosaurus.

IN a paper published by the Carnegie Institution of Washington (No. 101) under the title of "The Variation and Correlations of Certain Taxonomic Characters of Gryllus," Mr. F. E. Lutz records the results of a series of observations undertaken for the purpose of ascertaining whether detailed measurements of those parts of the body on which the distinction between the various American species of crickets mainly rests would afford absolute data for the determination of such species. The observations, which relate to an enormously large series of specimens, were intended to apply to the question of the exact definition of species in general. So far as American crickets are concerned, the results show that in the matter of length of various parts—especially the ovipositor—there is an almost complete gradation from the maximum to the minimum dimension, and consequently that the half-dozen or so species which have been named have no real existence in nature. Nevertheless, it is urged, the recognition of such species is advisable for convenience of reference. Local conditions of environment have, it is true, some effect on the taxonomic characters, such as the length of the ovipositor, but very similar variations occur in one and the same locality. It is added that these insects exhibit a dimorphic feature—namely, large or small wings—quite independent of the so-called specific characters.

IN his presidential address delivered before the annual meeting of the Linnean Society, held on May 24, Prof. W. A. Herdman discussed the question whether the practice of taking small samples of the oceanic plankton in particular localities at certain intervals of time affords a sufficient and trustworthy means of ascertaining the micro-organic contents of the oceans as a whole. As the result of observations at Port Erin, it has been ascertained that there exists, in the first place, a sequence and periodicity of stages in the life-history of these organisms; secondly, there are irregularities due to the interaction of organisms, as when one group serves as food to another; while, thirdly, there occur periodical changes and abnormalities of either time or abundance brought about by the nature of the water or by climatic conditions, which largely affect the plankton. From these facts it is clear that observations taken every three months, or even fortnightly, are inadequate to give a proper idea of the plankton of any one area, and it is therefore necessary to have samples taken weekly, and during three months of the year daily, to furnish a trustworthy basis of calculation. In the course of his address, the president directed attention to the occurrence in the Irish plankton of an extraordinarily large number of what are usually regarded as "oceanic" types.

THE report of the director of the Royal Botanic Gardens, Ceylon, for 1907, gives cover to the reports of the various officers attached. The post of scientific assistant to the director has been abolished. In connection with the curatorship of the gardens, Mr. H. F. Macmillan refers to the flowering of the giant bamboo, *Dendrocalamus giganteus*, and the giant orchid, *Grammatophyllum speciosum*; the bamboo has been flowering irregularly for three years, producing a proportion of fertile seed. An indigenous liliaceous plant, *Ophiopogon intermedius*, is recommended for edgings under the shade of trees. *Colvillea* *racemosa* and *Artocarpus cannoni* are two of the new introductions into the gardens; also the Lombiro and Manicoba rubber trees, and Manihot "von Piauhy."

THE records of Mr. T. Petch, Government mycologist in Ceylon, provide information regarding the manner in which certain fungi show different propensities in different countries. The "bleeding disease" of cocoanut trees in Ceylon is traced to the fungus *Thievalopsis ethaceticus*, that is known in the West Indies and Java as causing a disease of sugar-cane. *Pestalozzia palmarum*, which attacks cocoanut palms in the latter countries, produces the "gray blight" usually associated with tea in Ceylon. With regard to this species of Pestalozzia, Mr. Petch does not accept the European reference to a species *guepini*, and generally holds the view that identifications cannot be satisfactorily made on dried specimens sent to Europe.

MR. A. S. HITCHCOCK has rendered good service, more especially to American botanists, in making a careful examination of type-specimens of American species of grasses deposited in European herbaria. The results of his study of the grasses described by Linnæus, Gronovius, Sloane, Swartz, and Michaux are collated in the Contributions from the United States National Herbarium (vol. xii., part iii.). The author pursued his investigations in the herbaria of the Linnean Society of London, the Natural History Museums at South Kensington and Stockholm, and the Museum d'Histoire naturelle at Paris.

THE second number of *Parasitology* (i., No. 2) contains important papers on ticks, spirochætæ, and piroplasmata (by Prof. Nuttall), and one by Dr. Castellani describing a spontaneous liver abscess in a monkey caused by an amœba.

PROF. LEDUC gives an interesting account of the osmotic "growths" which develop when a fragment of a soluble calcium salt (nitrate or chloride) is immersed in a solution of sodium carbonate. The calcium carbonate formed develops into curious outgrowths resembling those of the lower plants, and having a cellular structure analogous to that of the latter (Festband der *Biochemischen Zeitschrift* für H. J. Hamburger, 1908, p. 280).

WE have received an advance copy of Messrs. Merck's report of recent advances in pharmaceutical chemistry and therapeutics for 1907. Within a compass of 262 pages a large amount of information on new remedies, &c., is given, and the report should be in the hands of every medical man. It is sent free on application to 16 Jewry Street, E.C.

THE Livingstone College Year-book for 1908 contains the annual report, notes on experiences of former students and on climatic outfit and hygienic questions, and a review of the progress of tropical medicine, together with a reprint of Sir Patrick Manson's opening address on tropical research. The Livingstone College aims to give elementary instruction in the principles of medicine and surgery to missionaries.

A CLEAR and somewhat detailed statement of the present position and recent progress of the science of comparative psychology is to be found in the June number of the *Psychological Bulletin*. Prof. John B. Watson contributes an article on the power of imitation in monkeys, which sets in vivid contrast the utterances of popular anecdote and scientific experiment. Working with rhesus and cebus monkeys, he has found it impossible to obtain any conclusive evidence for the presence of the function of imitation in its higher forms. This result is diametrically opposed to that previously obtained by Prof. Hobhouse in a series of similar—in part identical—experiments. Prof. Watson suggests that the monkeys used by Prof. Hobhouse had previously learnt a variety of tricks similar to those demanded by the experiments. In his own work this source of error had been carefully guarded against. The long review of the psychological literature of the past year which follows this article brings out very vividly the signal success which is attending the application of the experimental method to the problems of animal psychology.

WE have received from the Canadian Department of Mines, geological survey branch, a couple of admirably executed maps. One is a special contoured map of Rossland, British Columbia, drawn on a scale of 400 feet to the inch by Mr. W. H. Boyd, and the other is a topographical map of the Yukon territory on a scale of 32 miles to the inch, showing the position of the gold, silver, copper, and coal deposits.

THE annual progress report of the Geological Survey of Western Australia for the year 1907 (Perth, 1908) records much useful work done during the year. The account has been arranged upon slightly different lines from those adopted hitherto, in that all reports of a scientific character have been omitted, and their places taken by abstracts pending their publication in the Bulletins of the survey. Particulars are given of the results of boring for coal at various localities, of the reported gold discoveries at Mundijong, and of investigations of the wolfram and tin deposits near Brookton, and of the copper deposits at Yandanooka. Several minerals not previously noted as occurring in the colony were noted during the year, namely, meymacite (hydrated oxide of tungsten), tagilite (hydrated phosphate of copper), amazon-stone, zoisite, and hemimorphite.

THE elaborate character of the work being carried on by the United States Geological Survey in the investigation of the fuel values and possibilities of the coals and lignites of the United States is well shown in the report on the United States fuel-testing plant at St. Louis, Missouri, from January 1, 1906, to June 30, 1907 (Bulletin No. 332). The experts responsible contribute reports on field work, on the work of the chemical laboratory, on steaming tests, on producer-gas tests, on washing tests, on coking tests, on cupola tests for coke, and on briquetting tests. The briquetting plant has developed new possibilities in the utilisation of slack coal and of anthracite culm as an efficient locomotive fuel, and the producer-gas investigations have shown the availability of bituminous coal, lignites, and peat rich in volatile matter, for the production of power. We have also received a report by Mr. R. L. Humphrey and Mr. J. A. Holmes on the organisation, equipment, and operation of the structural materials testing laboratories at St. Louis, Missouri (Bulletin No. 329). Funds have been supplied to the Geological Survey by Congress for investigations of structural materials with the view of reducing the cost and improving the quality of the materials used in building and construction work. Equipment of an elaborate character has been purchased, and much work has been done in studying the properties of concrete and reinforced concrete, and in testing various materials to determine their relative value for mortar and concrete.

DR. E. J. SPITTA has published in the Journal of the Quekett Microscopical Club for April, recently received, a short address on a method of photographing very translucent diatoms at high magnifications. The necessary high magnification requires the use of rapid plates, and with these the image of each dot or pearl is seen to be surrounded by a halo of fog, due to optical causes. To remove this the author makes a copy of the negative through a positive, using at one or both stages of the process a plate of much lower speed than could be used for the original negative. By this means the contrast is increased, and the foggy appearance thus eliminated.

IN a pamphlet entitled "Ratio Coordinates and Carnot's Theorem" (London: Whittaker and Co., 1908, price 1s. net), "J. L. S. H.," of East London College, suggests a method of dealing with certain theorems in analytical projective geometry of quadric curves associated with triangles. His "ratio coordinates" of a point practically represent the ratios, with their signs changed, of the triangular or areal coordinates, their product thus being $-1$. Equations expressed in terms of these coordinates are neither homogeneous nor symmetrical, the equations of a straight line and a quadric being of the form of linear and quadric equations in two variables, namely, one of the coordinates and the reciprocal of another coordinate.

WE have received from the director of the Zi-ka-wei Observatory (near Shanghai) a copy of a new and carefully prepared word-code for transmitting typhoon and gale warnings, with particulars as to direction of motion, &c., to such lighthouses on the Chinese coast as possess telegraphic connection, and to some foreign places. A code has been in use for many years, and has from time to time been improved, but it became necessary to reduce, so far as possible, the work of the telegraph companies, who generously transmit the messages gratuitously. In our note of May 23, 1907, it was explained that captains of vessels leaving port were invited to repeat, under certain restrictions as to time, &c., the warnings they had seen in the harbours to lighthouses not yet electrically connected. The plan appears to have met with success, and orders to cooperate in passing on the signals in a modified and simple form have been issued by several naval commanders to their respective fleets.

THE results of an investigation of the connection between band and line spectra of the same metallic elements were described by Prof. W. N. Hartley, F.R.S., before the Royal Dublin Society on June 16. The author concludes that band spectra belong to the elementary atoms, and may be considered as caused, not only by the motion of translation of the atoms themselves, but also of the vibratory movements of the component parts within the atoms. The banded flame spectra of lead, antimony, bismuth, tin, zinc, cadmium, copper, silver, and gold are the spectra of the atoms. The lines of these elements also are the spectra of the atoms, and it is inferred therefrom that the component parts of the atoms are in a state of dissociation. It is concluded that the metallic elements with monatomic molecules which exhibit two spectra—one of lines and the other of bands—can exist in two different conditions, the difference being in the larger amount of energy associated with the atom which exhibits a line spectrum.

THE Journal of the Röntgen Society for July contains a paper by Mr. W. Duddell, the president of the society, on the measurement of the current through a Röntgen-ray tube. The current was derived from a 12-inch induction coil, the primary of which was supplied from the mains at 200 volts through a mercury turbine interrupter giving about seventy-five interruptions per second. The secondary current was rectified by a point and cup spark gap, and passed in series through the tube, an oscillograph, a thermoammeter, and a galvanometer, by means of which the shape of the current curve, the mean square current, and the mean current were respectively determined. The current curve was almost invariably a triangle with a very short base and a height from 30 to 45 milliamperes, the mean current varied between 0·5 and 1·2 milliamperes, and the root mean square current between 2 and 5 milliamperes. Mr. Duddell is disposed to think that there is a connection between the maximum value of the current and the "hardness" of a tube for a given mean current.

THE most recent experiments of Mr. H. N. Morse on the osmotic pressures of sugar solutions, as described in the *American Chemical Journal* for June and July, are characterised by so marked an improvement on the excellent results already obtained as to merit much greater attention than the titles of the papers would suggest. The earlier sources of error due to variations of temperature have been overcome by improved thermostatic methods, those due to the change of volume resulting from the displacement of the manometer connections have been reduced to insignificant proportions by improved mechanical arrangements, and the last remaining disturbance, due to the dilution of the contents of the cell during the periods of closing and opening, has now been got rid of. As a result, the errors of measurement have been reduced from an atmosphere or more to a few hundredths of an atmosphere only on pressures up to 24 atmospheres. In the experiments on glucose, eight duplicate determinations showed a deviation of 0·01 atmosphere only, whilst the two remaining pairs differed by 0·04 atmosphere. Observations of this degree of accuracy make it possible to follow, not only the main course of the osmotic pressure laws, but also the deviations from these laws, to which so much attention is being paid at the present time.

PROF. W. F. OSGOOD has given in the Annals of Mathematics (2), ix., 3, a simple proof of the rule for the differentiation of an integral when the independent variable enters into the integrand and also into the limits. The proof in question involves an application of Green's theorem. It may be noticed that for teaching purposes a geometrical proof is very useful, and probably sufficient.

AT the meeting of the Société française de Physique on July 3, an absolute torsion electrometer due to M. E. Salmon was exhibited. The arrangement follows that of the Kelvin absolute electrometer, the attracting plate, the attracted disc, and the guard ring being, however, vertical instead of horizontal. The attracted disc is supported by a fibre in such a way that when no electrical force acts on the disc its front surface is coplanar with that of the guard ring. When the potential to be determined is applied to the attracting plate, the disc moves outwards from its normal position, and is brought back by twisting the head of the suspending fibre through the requisite angle. The torsional constant of the fibre is determined by means of a thread attached to the centre of the disc, which passes over a pulley and supports a weight. The instrument has been used to measure potentials between 0·05 volt and 40,000 volts, and has an accuracy of about 1 per cent.

MESSRS. T. C. AND E. C. JACK will publish shortly a popular work entitled "The Wild Beasts of the World," edited by Mr. Frank Finn. The work will be illustrated with 100 reproductions in full colours from drawings, and will be published in seventeen parts at a price of one shilling net each part.

Messrs. Rowland Ward, Ltd., announce for publication next month a concise work on British birds, entitled "The Sportsman's British Bird Book," by Mr. R. Lydekker, F.R.S. The volume will be illustrated, and will appeal to the field-naturalist as well as to the sportsman.

The *Yorkshire Weekly Post* is publishing an interesting series of articles on "Natural History as a Shakespearean Study." The author is evidently a careful naturalist and a painstaking student of Shakespeare. The admirable natural history notes which occur week by week in our contemporary have been arranged under the present editor for the last fifteen years.

The Sanitary Publishing Company, Ltd., has published a second edition of "By-laws as to House Drainage and Sanitary Fittings made by the London County Council," annotated by Mr. Gerard J. G. Jensen and another. The new by-law made under the Metropolis Management Acts (By-laws) Amendment Act, 1899, which came into force in 1903, has been included in the new edition. The work also contains references to the by-laws of various other cities in the United Kingdom. The price of the volume is 3*s*. 6*d*. net.

## OUR ASTRONOMICAL COLUMN.

Sun-spots Visible to the Naked Eye.—The accompanying photograph of the sun, taken at South Kensington at 2h. 45m. (G.M.T.) on August 6, shows the large groups of sun-spots which have recently been visible to the naked eye.

A feature of the most recent sun-spot maximum (1905–6) has been the number of naked-eye groups that has been


Photograph of the sun's disc, 1908, August 6, 2h. 45m.

observed, and it is somewhat remarkable that at the present time, two or three years after the epoch of the maximum, there should be two such groups visible at the same time. Both the group in the S.W. quadrant and that near the centre were quite easily seen for several days after August 3, a dark glass being the only equipment necessary. The former first appeared, as a few small spots, at the limb on July 30, and developed until, as the photograph shows, it was more than 100,000 miles long on August 6. The group near the centre was first seen, at the limb, on July 31, whilst the smaller group preceding it apparently formed on the disc and was first seen on August 3.

A Brilliant Fireball.—Mr. Denning writes:—"While watching the eastern sky for meteors on July 28 at 11h. 6m., the north-west region was illuminated by the outburst of a very fine meteor at a low altitude, and a few days later brought me letters from several of its fortunate spectators. An observer at Brynmawr, South Wales, says he was startled by the sudden illumination, and turning round to N.W. he saw a ball of fire drop there, leaving a bright streak for a short time. The Rev. W. F. A. Ellison, of Fethard, Waterford, describes the meteor as unusually magnificent. The flash was more vivid than lightning, and there was a momentary streak left about 4° to the right of Polaris. Path about $325°+80°$ to $115°+65°$. Flight very swift, less than half a second. An observer at Naas, Kildare, wrote a description to the *Irish Times*, in which he says that the brilliancy of the fireball was so strong that it bathed the whole country in daylight for three or four seconds. It left a short streak, like a red bar, between $\gamma$ and $\beta$ Lyræ, but not quite connecting these stars. The meteor was also seen at Newtownwards, in co. Down, and by many others in different places. The radiant was at $302°+23°$, and the height of the object about eighty-two to forty miles above Tullow and Kildare. The length of visible path extended more than fifty miles, and the velocity was very great and equal to 100 miles per second according to Mr. Ellison's estimate. The fireball would have fallen to the earth in west Meath could it have withstood disruption during a further flight of forty-eight miles. It was by far the finest meteor of the July epoch, and this is a period specially noted for the abundance and brilliancy of its meteoric phenomena. The shower in Vulpecula, near Sagitta, has frequently been observed at Bristol. This year, between July 22 and August 3, I recorded twelve meteors from it; they were swift and generally inconspicuous objects. Three were seen (one of mag. 3 and two of mag. 5) on the night of the fireball, and this amply proves that meteors great and small are commingled in showers of this character. The swiftness of motion is noteworthy. We should expect slow meteors from a radiant at $302°+23°$ at the close of July."

The Large Meteor of June 28.—Other observations having come to his knowledge, Mr. Denning has been able to compute the path of the supposed bright Scorpiid seen by him on June 28. He finds that the observed path commenced, at a height of sixty-nine miles, near Mere (Wiltshire), and ended, at a height of forty-five miles, over Kineton (Warwickshire), the length of its path being eighty-four miles and its velocity twelve miles per second. The radiant was at 237°, −18°, about 15° W. of the usual Scorpiid radiant, so it appears that this object was in reality a member of the neighbouring Librid shower (the *Observatory*, No. 399, p. 318, August).

Observations of Encke's Comet.—Encke's comet was photographed by Mr. Woodgate, with the 13-inch astrographic telescope at the Cape Observatory, on five nights from May 27 to June 5, and the reduced positions, for 1908·0, are published in No. 4266 of the *Astronomische Nachrichten* (p. 297, August 1). The comet is recorded as being very faint, and it is stated that the images are diffused and irregular in form, the diameter exceeding 1′ of arc.

A Variable Star of Remarkably Short Period.—The examination of the Paris *carte du ciel* plates has led M. Baillaud to the discovery of another variable star of which the period of light-variation is a remarkably short one. The star in question is situated in the position (1900) R.A. = 14h. 41m. 31·8os., $\delta = +23° \; 43' \; 59''.7$, and its range of variation is between magnitudes 12·8 and 14·3. The change from minimum to maximum takes about 0·070d., or 1h. 41m., and the complete period is either 7h. 54m. 26s. or 11h. 51m. 43s. The star is of the $\delta$ Cephei type, and there is a suspicion of a secondary maximum 1h. 40m. after the principal maximum (*Comptes rendus*, No. 4, p. 230, July 27).

## ECONOMIC GEOLOGY IN THE UNITED STATES.

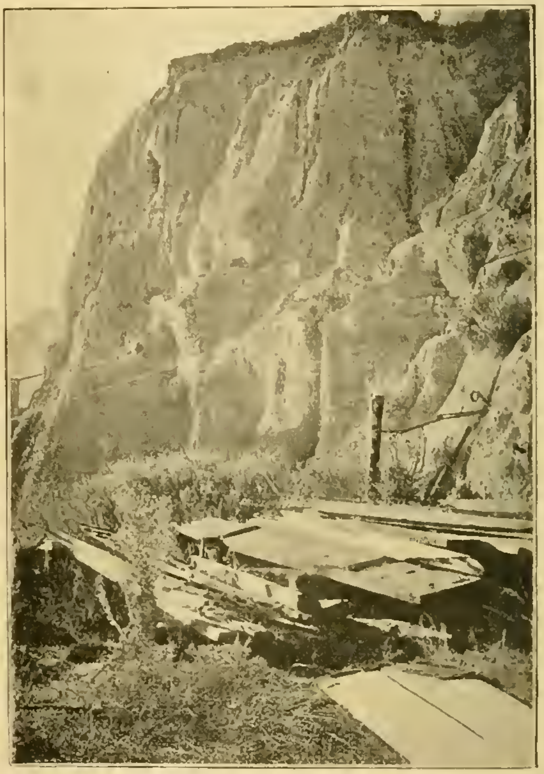
A MASS of official publications received from the United States Geological Survey bears striking testimony to the extensive and admirable work which is being carried on by that body for the direct advancement of mining interests throughout the country. During the year ending June 30, 1907, the sum of 308,404*l.* was appropriated for the survey, and a large proportion of that amount was devoted to investigations of an economic character. The Bulletins published are admirably edited and copiously illustrated with plates and geological maps. The most valuable of the series is Bulletin No. 316, dealing with contributions to economic geology bearing upon coal, lignite, and peat. Special investigations were made to determine the extent of the coal lands remaining in the possession of the Government, and the quality and value of the coal deposits on these public lands. The survey has been giving more and more attention to the subject of coal, both as regards its geological relations and its technology. The brief reports contained in the Bulletin, the object of which is to secure prompt publication of the economic results of the investigations of the survey, have been edited by Mr. M. R. Campbell, and deal with work in the coalfields of Pennsylvania, Kentucky, Virginia, Alabama, Illinois, Arkansas, Montana, Wyoming, Colorado, Utah, New Mexico, and California.

The technological work of the survey on fuels was started at the St. Louis Exhibition in 1904, and has since then been extended in scope. Much of the work of the branch has been the testing of waggon-load samples of coal under the direction of Mr. J. S. Burrows, who contributes a valuable paper on the importance of uniform and systematic coal-mine sampling. One of the most important results of these tests is the demonstration that producer gas for power purposes can be made successfully from all grades of bituminous coal, lignite, and even peat. The results of these tests, which are discussed in a paper by Prof. R. L. Fernald on the present status of the producer-gas power plant in the United States, point conclusively to the substitution of producer-gas plants and gas engines for the generation of power in place of the wasteful steam engine now in general use. Another field of investigation which promises to have a distinct bearing upon the better utilisation of American coal is that of briquetting, and the present condition of the briquetting industry is summarised in a paper contributed by Mr. E. W. Parker.

In addition to No. 316, we have received six other Bulletins dealing with coal. The Arkansas coalfield is described in detail by Mr. A. J. Collier (Bulletin No. 326), who shows that its structure is more complex, and the areas of workable coal more limited, than the results of previous surveys would indicate. The coals are, however, of a quality not to be found elsewhere in the United States west of West Virginia. In Bulletin No. 325 Mr. L. P. Breckenridge gives the results of a study of four hundred steaming tests made at St. Louis. Mr. D. T. Randall submits a preliminary report (Bulletin No. 334) on the burning of coal without smoke in boiler plants. Washing and coking tests of coal and cupola tests of coke, made at St. Louis, are described by Messrs. R. Moldenke, A. W. Belden, and G. R. Delamater (Bulletin No. 336). A study of the numerous tables given indicates many important facts as to the behaviour and treatment of the coals mined in the various portions of the United States when prepared as metallurgical coke.

Bulletin No. 333 is a preliminary statistical report on the causes and prevention of coal-mine accidents, by Mr. Clarence Hall and Mr. W. O. Snelling. The matter was taken up in consequence of the transference of the general supervision of the work of the coal-mine inspectors in New Mexico and Indian territory to the Geological Survey on June 10, 1907. The figures given in the report are most depressing. During 1906 nearly 7000 men were killed or injured in the coal mines of the United States, and the number of accidents caused by explosions has been steadily increasing. Experience in deeper and more dangerous mines in other countries indicates that these mine accidents might be reduced to one-third their present number. In Bulletin No. 339 Mr. D. T. Randall discusses the purchase of coal under Government and commercial specifications on the basis of its heating value, and gives analyses of coal delivered under Government contracts. The necessity for a more uniform standard in the purchase of coal is apparent, and there is much to be said in favour of the plan of buying it on the basis of its heating value, a plan already adopted by several Government departments and by many large commercial consumers.

The petroleum resources of the United States have received careful attention from the survey. The growth of the consumption of fuel oil in California has led to the publication of reports on the Santa Clara Valley, Puente Hills, and Los Angeles oil districts by Mr. G. H. Eldridge and Mr. R. Arnold (Bulletin No. 309); on the geology and oil resources of the Summerland district, Santa Barbara County, by Mr. R. Arnold (Bulletin No. 321); and on the geology and oil resources of the Santa Maria oil district in the same county, by Mr. R. Arnold and Mr. R. Anderson (Bulletin No. 322). The region near the Pacific coast in Santa Barbara County has shown promise of becoming one of the most productive oilfields of the West, if not of the whole United States, and the geological investigations recorded in these Bulletins cannot fail to aid in the extension of developments. The character of the country is indicated by the accompanying view showing unconformity near North Star Wharf, in the Summerland area. The Pleistocene deposits are seen to be resting on nearly vertical oil-bearing sandstone and conglomerate.



Unconformity near North Star Wharf, looking West. Pleistocene deposits resting on nearly vertical oil-bearing Fernando sandstone and conglomerate.

The mineral resources of Alaska are investigated by a distinct division of the survey. The geography, geology, and mineral resources of the area north-east of the head of Cook Inlet have been studied by Mr. S. Paige and Mr. A. Knopf, whose results are given in a report on the Matanuska and Talkeetna basins (Bulletin No. 327). The territory mapped covers an area of 7000 square miles. The principal resource of the region thus far developed is coal. As a portion of the coal is of high grade, comparing favourably with Pennsylvania bituminous coal, and as anthracite is also met with, the investigation was directed to determining the boundaries of the various coal-fields and to ascertaining the ages of the various coal horizons. The occurrence of gold- and copper-bearing rocks is also recorded.

The investigations of structural materials begun in 1905 has been continued, and a valuable report on Portland cement, mortar, and their constituent materials has been drawn up by Mr. R. L. Humphrey and Mr. W. Jordan (Bulletin No. 331).

The work of the survey includes investigations of underground water, and in order to furnish trustworthy information on general principles, Mr. M. L. Fuller has drawn up a very instructive summary of the controlling factors of artesian flows (Bulletin No. 319). The term "artesian" is applied in the sense adopted by the survey, namely, to designate the hydrostatic principle by which confined waters tend to rise in virtue of the pressure of the overlying water-column, whether or not this pressure is sufficient to lift the water to the surface and to produce a flow.

Lastly, there is the work of the mining division of the survey. The outcome of the work, a volume of 1307 pages, contains the report on the mineral resources of the United States for 1906. Much of the information given has already been published as advance chapters. Suffice it to say that the year 1906 was by far the most prosperous ever known in the mining industry of the United States. The total value of mineral products amounted to 380,000,000*l.*, an increase of more than 15 per cent. over the value of the output in 1905. Compared with the previous volume of the series, noticed in NATURE (vol. lxxvi., p. 257), several changes are apparent. The smaller type, which was tiring to read, has been abandoned, and several new names appear as the authors of the various chapters. This is in pursuance of the policy of the new director of the survey of assigning all subjects to members of the survey who are employed solely in the Government service. This has doubtless been conducive to economy, but there is the loss of the authority given to the reports by the signatures of such experts of world-wide reputation as Mr. James M. Swank, Mr. Charles Kirchhoff, Mr. John Birkinbine, and Dr. George F. Kunz. The annual reports of the last-named authority on precious stones were works of originality and of great literary charm, whilst the report on precious stones in the present volume is an arid catalogue of facts. The reports on gold, silver, and quicksilver are more successful, the technical knowledge of the authors as mining geologists serving as compensation for their lack of experience in statistical work.

The reports reviewed in this article cover 2239 pages. It has, therefore, obviously been impossible in the space available to do more than indicate briefly the nature of their contents in order to induce those interested in the various branches of economic geology dealt with to peruse the original reports, which will well repay careful study.

## THE SYNCHRONISATION OF CLOCKS.[1]

THE hon. secretary of the British Science Guild has sent us a copy of a report on the synchronisation of clocks which has been adopted by the executive committee, and is here reprinted. Steps are being taken to carry out the recommendations contained in the report.

The committee wish, in the first place, to direct prominent attention to the fact that a very large amount of most excellent work in the matter before the committee has already been done by the General Post Office in disseminating standard time in London and large provincial towns, and also to outlying districts in Great Britain, though in the latter case the arrangements, perhaps, are not quite so perfect as in the large towns.

They also wish to state that private companies, like the Standard Time Company, Ltd., are doing excellent work in the same direction in London and its neighbourhood. They are, however, of opinion that much more has still to be done before London and other parts of the country can be said to be in a satisfactory condition as regards the time shown by its public clocks, and they consider the time has come when public action is urgently demanded.

Greenwich mean time is of course recognised as the standard time for the whole of Great Britain, and this time emanates from the mean solar clock at the Greenwich Observatory.

The problem, therefore, is solely how to make this time available throughout the country in the widest and easiest manner possible, and at the lowest possible cost to the State or public, and also so as not to interfere in the slightest degree with any telegraphic or telephonic services at present in use.

The present arrangements as to the dissemination of this time in London and elsewhere may, perhaps, be described with sufficient accuracy as follows:—

Greenwich mean time signals are transmitted at the sixtieth second of each sixtieth minute day and night to the General Post Office, London, and daily at 10 a.m. to every telegraph office in the kingdom, when the signal then sent from the mean solar clock at Greenwich Observatory is received at the Central Telegraph Office in London upon apparatus which is known as the chronopher, the function of which is to distribute automatically the signal to the larger provincial telegraph centres.

By means of a clockwork arrangement, electrically controlled by a regulator clock, the telegraph lines are disconnected from their respective telegraph instruments and are joined to the relays of the chronopher at two minutes before ten, in readiness for the signal from Greenwich. The time current passes exactly at ten o'clock, and the normal connections are restored by the clockwork at two minutes past ten.

From the large centres the word "ten" is signalled to all the small towns and villages.

In London "nine" is signalled to all London offices connected to what is known as the "main inter-communication switch" in the Central Telegraph Office, and an hour later, when the "chronopher" signals "ten" o'clock time to provincial offices, "ten" is also signalled to the remainder of the London telegraph offices.

From the Post Office the public may in London, by arrangement and by paying a certain annual sum, obtain the hourly Greenwich mean time signals.

In other cases, one or other of two daily signals, at ten o'clock and at one, can be sent to places in the provinces, but the number of private subscribers for such signals is relatively small.

At present the signals from Greenwich sent *via* the Post Office only give the indications of the exact time by sounding bells or deflecting needles, and are not generally utilised to influence individual clocks or to control them, it being left to the individuals in charge of such clocks to make use of these signals, and to set their clocks accordingly.

It is at this point that much is to be desired in the present arrangements, for there is no doubt that many clocks are not as accurately set as they should be.

In addition, these time signals are communicated, amongst others, to private companies like the one previously referred to, and this company, or similar companies, make it their business automatically to re-distribute them to their subscribers in such a way that the electrical signals actually set the clocks of the subscribers to the correct standard time at the moment of each signal.

It would appear, therefore, that there is no general system by which the public is provided with the means of getting exact standard time, such as would be the case if there were an arrangement by which time balls in prominent positions could be electrically dropped, or time guns fired at any fixed hour. In the case of London, the area to be covered would prohibit any such treatment of the case.

The committee are strongly of opinion, and think it highly desirable and important, that arrangements should be made so that a number of public clocks in different districts of London and in other large towns, and perhaps the clock at a telegraph office in smaller towns and villages, should at certain hours be *automatically* corrected to agree with the true standard or Greenwich mean time, and that these clocks should be known as standard clocks, and be thus marked or labelled.

[1] Report of a Committee of the British Science Guild on the subject of the synchronisation of clocks in London, and in other parts of Great Britain.

The committee examined the point as to whether even the best of clocks could be depended on always to show true standard time, and, after full discussion, decided unanimously in favour of some form of control of public clocks by electric synchronisation by signals from the central time authority, and decided that the control and correction of such public clocks by hand is quite out of date and untrustworthy, and should be abolished.

The committee are given to understand that arrangements exist by which, given an electrical signal at certain specified hour or hours of the day, the hands of a clock can be automatically set to indicate the absolutely correct time, and they also understand that such arrangements can be applied to existing clocks at a very small cost.

The committee are informed that there are several distinct methods of synchronising public and other clocks.

In one, used in connection with large clocks, a slight gaining rate of the pendulum is compensated by arresting the clockwork, by means of the time signals, for the number of seconds or parts of seconds gained since the previous synchronisation.

In another method, applied to smaller clocks, the hands are mechanically set forward or backwards to standard time by an electromagnet, excited by the time signals.

It would not be difficult to provide for clocks automatically to come into circuit on telephone and private wires at stated intervals, in order that the time currents might affect the electrical controlling devices of both types referred to above, if this were thought advisable.

The utilisation of telephone and private wires used for correspondence for the synchronisation of clocks would naturally involve the suspension of their use for conversations during the short periods that they would be connected to the electrical controlling devices at the hours at which the time currents were due.

The system involves, therefore, first of all, a system of wiring for the electric signal; and, secondly, the necessary apparatus in each clock. The cost will evidently depend on the charge for the signals, the charge for the use of the wires and of the apparatus in the clocks. The first and last will be small, and the second will depend on the rate per mile charged for the use of wires.

It is obvious that as such a system for communicating electric signals already exists in the telegraphic and telephonic wires belonging to the Post Office, it would be quite unnecessary to set up an independent system of wiring for the time signals. If this is accepted, and if the synchronisation of public clocks becomes general, it is obvious that such signals must not be sent too often, and that they must be sent at a time when such wires are more or less free from the ordinary traffic. It would appear to the committee that for most purposes a single automatic signal once a day, at some convenient time of the night, perhaps at 2 a.m. or 3 a.m., would be enough, but if greater accuracy were desired more frequent signals could be made. If found necessary, signals might even be sent twice or three times a day to synchronise clocks, such as at 8 a.m. and 8 p.m., or, in addition, at 2 p.m., when in the early morning and evening the wires would certainly not be overburdened with work, but such details could be considered later on.

The question of the public or private distribution of such signals was briefly discussed, and the committee considered that any recommendation on this subject would be out of place, but they would merely point out that the initial signals giving true time must come from a public source, *i.e.* Greenwich Observatory, and there is little doubt such signals must be mainly transmitted by the wires of the General Post Office, though perhaps it is an open question whether the apparatus in the clocks themselves for utilising such signals should be a public enterprise or be done privately.

As a beginning, it would probably be well to take a few large public clocks in London and have them synchronised, and these could then be set apart and considered as "standard time clocks."

The nearest approach to a standard time public clock in London at present is probably that in the Clock Tower at Westminster. From the report of the Royal Observatory, Greenwich, read at the Annual Visitation on June 8, it would appear that the maximum error of "Big Ben" during the preceding year did not exceed three seconds, except on two occasions. This may be accepted as sufficiently accurate for ordinary purposes.

Many other public clocks, on the other hand, constantly show variations, running to minutes, and such clocks clearly should be electrically synchronised as far as possible.

Clocks like that at the General Post Office in St. Martin's-le-Grand, at the Royal Exchange, and others in large public buildings should, it is submitted, be *automatically* or *electrically synchronised*, and be considered as "standard time clocks." A few of them might be taken up as a commencement, and synchronised once or twice a day.

As most public clocks have no arrangement for showing seconds, the exact time to seconds cannot be shown on them, but as most public clocks are striking clocks, it might be arranged that the first stroke of the hour bell should be the signal indicating standard time, so that persons could tell the time accurately to a second from such signal.

It remains, therefore, to consider what can be done in the case of London in the first instance.

The following would appear to be the actions necessary to be taken by the Guild:—

(1) To approach the Postmaster-General, to ask that in the case of post offices the time signals sent to the offices should actually automatically set at least one of the clocks in each public office to standard time, and not merely indicate standard time and depend upon subsequent hand correction of the clocks, as at present.

(2) To form a deputation to the L.C.C. to ask them to have all public clocks under them, or in any way under their influence, synchronised in the same way.

(3) To take similar action with reference to the clocks under the control of the Corporation of London.

(4) To take similar action with reference to the clocks at railway stations in London.

(5) To take similar action with reference to the Office of Works, which it is believed is responsible generally for the clocks in Government departments, some of which exhibit large clocks, and which, therefore, should be synchronised.

(6) To ask the Local Government Board to take the necessary steps to secure the passing of a bye-law calling upon persons exhibiting clocks publicly to have such clocks synchronised, or, failing this, for such clocks to be done away with.

Similar action could be taken later on for provincial towns, and afterwards for smaller centres in Great Britain.

## *EDUCATION AT THE FRANCO-BRITISH EXHIBITION.*

UNDER the chairmanship of Sir William Mather, the committee of the Education Section of the Franco-British Exhibition undertook to exhibit to the British public and our French visitors the principles and methods of our national education in all its branches and phases. So formidable a task has not been attempted heretofore in this country, and a very large amount of well-directed labour must have been spent in achieving such a great measure of success. We shall have occasion to point out certain respects in which the results fall short of the ideal; but the more closely one investigates the exhibits, the more one marvels at the thoroughness with which the display has been organised. The nearest approach from the Wood Lane entrance is through the hall of textile and chemical products, whence we enter the west end of the building (300 ft. × 200 ft.), devoted to British and Irish education. The chief decoration is a series of pleasing frescoes forming a deep frieze along three sides of the hall. These depict in allegorical form the virtues which schools seek to develop, and all have been designed by students of the Royal College of Art. We may mention that all the exhibits—with the exception of statistics and a few other administrative matters—are the work of children, students, and teachers, from the infant school to the University or technical college. The west wall is occupied by colossal maps showing the exact position of every public educational institution in the British Isles, with panels of statistics.

It appears that there is no class of the people in any district without facilities for education, but it must be admitted that the quality of these facilities is not everywhere such as to leave no scope for the reformer's zeal. Perhaps Ireland illustrates most clearly the progress made in the last decade. Prior to 1899 there was little technical education in Ireland, and in 1900 there were not more than half-a-dozen laboratories in the secondary schools. Now there are 280 laboratories, and 15,000 students are to-day being taught experimental science. There are but few secondary schools where such teaching has not been introduced. In addition, there are under the Department of Agriculture and Technical Instruction 45,000 students, and visitors will hardly fail to notice the specimens of their work which are on view; the Arts and Crafts Section being of considerable intrinsic merit.

Starting from the west and working towards the east end of the hall one passes from kindergarten to university. In valuing the work, especially of the young children and of the boys and girls of our elementary and secondary as distinct from technical schools, we must not lose sight of the true aim of the educator. Our judgment should be based, not on the intrinsic value or the "finish" of the exhibits, but on the extent to which their production is calculated to aid disciplined development of character, mind, and physique. From our increased expenditure on education we may look for more than improved school-attendance. We ought to find in this exhibition signs that a balanced and harmonious growth of all faculties is being encouraged by normal school-courses, apart from educational fads.

*Elementary Schools.*—During the last few years the improvement in infants' schools has been very great. To appreciate rightly the work of their highly competent teachers, one ought not to be content with examining the schemes of work, models, and drawings to be seen in the exhibition hall, although these bear witness to enthusiastic work. One ought also to visit an infants' school, see the conditions of work, and obtain personal experience of the skill with which modern teachers deal with the difficult task of setting drafts of babies to happy, intelligence-forming work and play. The work of elementary, higher elementary, and higher grade schools is very well displayed. We select the exhibits of the London County Council and the City of Manchester as furnishing an index to such work. We find:—(1) *Albums* which contain schemes of work, time-tables, photographs, and specimens of work; (2) *mounted illustrations* of syllabuses in drawing, science, needlework, domestic economy, wood-work, physical exercises, nature-study, geography; (3) *class-worked exercises* connected with the foregoing. The feature which impressed us most was the large share of attention given to drawing, nature-study, physical exercises, and organised games. The development of motor-activities appears to be the guiding principle. Certain of our writers and public speakers who constantly inform us that our methods are too "bookish" are under the mistaken impression that schools of to-day are still in the old grooves. A visit to the British Education Section might make them wiser and happier men. The science, domestic, and art teaching is of the type which calls upon the pupil to take an intelligent share in the work, and to employ his or her inventive powers. Presumably less time is given to reading and spelling in the first stages; but we did not observe any resulting defects in the later work. Rather we think that there is a better power of expression in the higher standards; probably the result of improved general intelligence, stimulated by modern methods. It should be mentioned that the housewifery is quite practical and simple, not *in nubibus*. Moral teaching is given with a straightforward dogmatism suited to the age of the children. The extent to which individual ability and self-reliance are being encouraged in the schools is most creditable when the conditions of work are considered.

In the higher elementary schools the study of physics is encouraged. Geography makes a good show; especially worthy of notice is the geography scheme of Basnett School, Battersea. Modern methods, based on regional survey, have been successfully applied in a district which at first sight appears to offer drawbacks rather than facilities. Despite the fact that history receives more attention than formerly, the utility of charts, pictures, &c., seems underrated. There is little evidence in this exhibition of "the appeal to the eye" in connection with history teaching in elementary schools.

*County Organisation.*—This is clearly exemplified in the cases of Essex, Warwickshire, and Northamptonshire, which afford good examples of decentralised administration with especial reference to local needs and industries. The combination of counties to permit interchange of teachers and scholars for the purpose of training or to form other centres of higher education is still to a great extent an unfulfilled aspiration. Perhaps the next great exhibition will be able to illustrate useful results from the working of neighbouring authorities in association. The Essex authorities have furnished much useful information as to the cost of salaries, buildings, and school supplies generally.

*Public Schools and the older Universities.*—The deepest matters of education have to do with "things unseen," and it does not follow that Oxford does less for the nation than a domestic economy or engineering school because the products of the latter institutions bulk more largely at Shepherd's Bush. So far as Oxford and Cambridge are concerned, we must thank those responsible for their interesting display of portraits, relics, and models, and the copious supply of photographs and official publications. Perhaps this was all that could be done; one cannot "allot space" to the spirit of a university. But something more ought to have been done to furnish visitors with a concept of that characteristic institution, an English Public School. At least, the committee ought to have acquired a model of buildings, playing-fields, &c., such as are to be found in the all-round equipment of our public schools, and are not to be found in any other country in the world. (We remember a model of Rossall School which created great interest some seven or eight years ago.) A critical observer will find much worth attention in the portfolios and exercise books. They show the actual everyday work of the boys. The pursuits of their leisure hours are copiously illustrated.

*London University and the newer Universities.*—Special handbooks are issued by the London University and by the deans of the metropolitan schools of medicine. We do not think that so clear and concise a statement of the multifarious activities of the University had been published hitherto. The illustrated guide to the medical schools is a good-sized volume, full of interest to all concerned in medical education. It is important to observe how the opportunities for clinical study and research are being extended, and that these opportunities are appreciated by large numbers of qualified men. The movement for promoting social intercourse among undergraduates by athletic clubs and halls of residence is gaining ground. Victoria and Sheffield Universities are strongly represented on the technological side. We are interested by a photograph taken at the Mason College, Birmingham, where the lecturer is seen addressing a theatre crowded with working men. There is room for more of this kind of university extension.

*Girls' Education.*—Nothing is more clearly shown than the strides made in the education of girls, especially in domestic subjects. Neither in the elementary nor in the secondary and high schools is to be found unreasoned imitation of boys' education. The work shown by the Cheltenham Ladies' College and by the Manchester High School is of a high standard, the humanities being well cared for.

*Technical Instruction, Fine Arts, Arts and Crafts* occupy an important place. The difficult task of selecting really typical work from the technical schools of the country was performed mainly by the Association of Technical Institutions. A display of real educational interest is the result. The growth of organised instruction in the different branches of industrial work is well evidenced by the exhibit of the City and Guilds Institute. The students' work in the fine arts and arts and crafts compares not unfavourably with the corresponding trade exhibits in other halls of the exhibition.

*Music.*—The weak spot in the exhibition is that the claims of music have not been recognised. The Guild of Church Musicians furnishes the only exhibit we discovered. A hall for demonstrations and lectures has just been erected, and we ventured to suggest that demonstrations of school-music would be welcome.

*Special Institutions.*—The work that is being done in schools for the blind, the deaf, and the mentally defective calls for respectful acknowledgment. Cases showing what is being accomplished, so far as material products are concerned, can be seen near the entrance. The moral benefit to the pupils cannot be expressed.

It reflects credit on the committee and the secretaries that the whole of this wonderful collection was in place at the opening of the exhibition. The objects are displayed in an admirable manner, and furnish innumerable suggestions of value to the practical teacher.

*French Education Exhibit.*—Although not large enough to furnish grounds for comparison of French with English organisation of education, the French section contains many interesting features. It is housed in the corridors between Shepherd's Bush and Wood Lane, unfortunately rather distant from the English section. The *Écoles Professionelles, l'Enseignement Technique*, and the *Ecoles Primaires Supérieures* contribute; Lille, Toulon, St. Etienne, Nîmes, Dupuy, and Rouen are represented.

Much of the manual work is excellent, and teachers of chemistry may glean some useful hints from the apparatus and diagrams, which are clearly displayed. There has been an attempt to introduce some really artistic adornment into certain of our own elementary schools; but we still have much to learn in this respect. Our authorities would do well to pay attention to the charming pictures sent by the Société Artistique de l'Art à l'Ecole. Incidentally, we observed that Arabic was included in the curricula of some pupils whose note-books we inspected.

Undoubtedly the space allotted to the French education section is too small, and hence the display falls short of our expectations. We admit that those expectations were high. In justice to the work performed in bringing together the exhibit, we should add that the interesting quality of what we could see considerably strengthened our desire for a fuller display of recent achievements by our neighbours in the field of education.

G. F. DANIELL.

## THE ELECTROCHEMISTRY OF LIGHT.

IN the April and May numbers of the *Journal of Physical Chemistry*, Mr. Wilder D. Bancroft contributes two long articles under this heading, long chiefly because of the very extensive quotations from the writings of Grotthuss, Herschel, H. W. Vogel, E. Vogel, Timiriazeff, Acworth, v. Hübl, Bothamley, and others whose work bears upon the subject. The object of the communication is "to bring the various catalytic actions of light under one head so far as possible," and to show that this may be done by accepting two laws enunciated by Grotthuss some ninety years ago:—(1) that only those rays of light which are absorbed can produce chemical action; (2) that the action of a ray of light is analogous to that of a voltaic cell. The action, therefore, is regarded as electrolytic, and sensitisers, whether "optical" or "chemical," are viewed as depolarisers. The fundamental conception of Grotthuss, that the action of light is essentially electrolytic in character, is held to be sound and to accord with modern notions, though the language in which he expressed it may be somewhat obscure.

The author proceeds to show that the decomposition of various salts containing silver, iron, copper, mercury, chromium, uranium, manganese, vanadium, and molybdenum, as the result of light action yields the same products as those resulting from electrolytic action, but that some substances are light-sensitive only in the presence of a suitable depolariser (or absorber of one of the products of the decomposition). Herschel's account of his experiments on the action of light upon iron salts and ferro- and ferricyanides is quoted in full from the Philosophical Transactions. When paper is impregnated with a mixture of potassium ferricyanide and ferric chloride and exposed to light, the ferric chloride is reduced and Turnbull's blue is formed, further exposure giving a brown substance of unknown formula. The author records that since his writing Mr. Schluederberg has succeeded in producing this brown substance by electrolytic means. Herschel's observation that by the continued exposure of a Prussian-blue print to light the colour was bleached, but that the colour returned when the print was left in the dark, and that this reversal took place even when the iron salt was exposed alone and the ferricyanide added afterwards, is explained by the supposition that the light, after it has reduced the iron of the ferric ammonium citrate to the ferrous state, by its prolonged action produces a reducing agent powerful enough to reduce the ferricyanide, the white ferrous ferrocyanide that results being re-oxidised in the dark.

The analogy between the oxidation of organic bodies by the action of light and by electrolysis is not so easy to trace for want of facts. Whether the oxygen (of the air) or the dye is the depolariser must be decided experimentally in each case, and "there is one conclusive way" of answering this question. "If the active light is light which is absorbed by the substance to be oxidised and not by the oxygen, then the substance to be oxidised has been made active by the light and the oxygen is the depolariser. If the active light is absorbed by oxygen and not by the substance to be oxidised, then this latter is the depolariser, and the oxygen is made active by light. If the active light is absorbed by both, it is possible that each is made active and that each is also the depolariser. In this last case, however, the results should be checked by experiments with another oxidising agent and another reducing agent. While light can only act in case it is absorbed, it does not follow that all light which is absorbed acts to any appreciable extent." In the bromination of organic compounds, Schramm and Zakrzewski have shown that the most effective rays correspond to the weaker bromine absorption bands in the yellow-green and orange instead of the stronger bands in the greenish-blue and blue. The researches of Herschel on the action of light on the colouring matter of flowers are explicable by the Grotthuss theory, and Timiriazeff in his Croonian lecture (1903) showed the strict applicability of the law so far as regards the correspondence between the absorption of light and its chemical action in the case of chlorophyll.

In some cases the depolariser changes the sensitiveness of the system with regard to certain rays. These substances are generally distinguished as "optical sensitisers," but, the author says, "a more rational distinction would be between depolarisers with marked absorption bands and depolarisers without marked absorption bands." The discovery of the action of "optical sensitisers" by H. W. Vogel in 1873, that is, the possibility of sensitising photographic plates for the less refrangible rays by means of dyes, and Eder's work that led him to the conclusion that the absorption of silver bromide dyed with eosin and the maximum of the photographic sensitising action of eosin on silver bromide exactly coincide in the spectrum, are detailed by copious extracts from the writings of these investigators. Eder distinguished between the absorption of the dyed silver salt and a dyed gelatin film or aqueous solution of the dye, the former giving an absorption of greater wavelengths, in accordance with Kundt's law. Acworth, who worked under apparently ideal conditions, comparing the maxima of absorption and sensitiveness by estimating them in the same emulsion, found that the sensitiveness maximum was displaced towards the red as compared to the absorption maximum, and Wiedemann accounts for this by suggesting that the light at the place of maximum absorption may cause increased vibration within the molecule, resulting in radiations or heat waves, but without the amplitude of vibration in the molecule attaining a sufficient magnitude to result in any decomposition or chemical change of the molecule. Mr. Bancroft accepts Acworth's experimental results, but considers that his absorption curves show the sum of the absorptions of the dyed gelatin film and the dyed silver bromide, instead of the absorption of the latter alone, and that therefore his results do not disprove Eder's conclusions that the maxima of absorption and photographic effect coincide.

Concerning the mode of action of such sensitisers, he states that the theory of Grotthuss enables us to make a definite statement with regard to them, "and one that differs to a certain extent from any of the previous ones.

A sensitiser must be a depolariser, directly or indirectly. It must be a reducing agent in the broad sense of the term, or it must be changed into one by the action of light. In either case the sensitiser is decomposed by the action of light on the sensitive plate." In support of this position he quotes Bothamley's observation that sensitisers act and a developable image is produced on exposure when the plate is immersed in a powerfully reducing solution, as proving that the dye is not oxidised by exposure as Abney suggested, and shows that the instability of the dye on exposure to light is generally acknowledged as a necessary condition for it to act as a sensitiser. This theory also explains Abney's experiment of exposing a collodion film stained with cyanine to the spectrum, and then coating it with a silver bromide emulsion and developing. The silver bromide was developed to an image over the absorption band of the cyanine, though the silver salt had never been exposed to light.

Among the general conclusions referring to this part of the subject that the author gives in his summing up, the two following have perhaps not been indicated in this abstract, namely:—(1) whether any substance is reduced or oxidised by light depends on the depolariser, and (2) all sensitisers are light sensitive, but the light sensitiveness and sensitising power need not run strictly parallel. Finally, he maintains that the electrochemical theory of light, first proposed by Grotthuss, accounts for all the known facts concerning the action of sensitisers and the action of light upon salts.

In a third chapter (*Journal of Physical Chemistry*, June) Mr. Bancroft deals in a similar way with the action of chlorine and bromine on organic bodies, and the effect of halogen carriers upon the reactions in darkness and in light. He deals with benzene and toluene, and the formation of addition and substitution derivatives, distinguishing in the case of toluene between the replacement of hydrogen in the ring and in the side chain. After summing up the known facts and showing wherein other theories are deficient, he quotes the suggestion of Bruner that chain substitution is due to the bromine molecule and ring substitution to free bromine atoms, the preponderance of ring substitution when the reaction takes place in nitrobenzene as a solvent being "certainly connected with the fact that bromine and a *portion* of the acid of the polybromides is dissociated into ions" in this solvent. Mr. Bancroft agrees with this theory in the main, but carries it further. He assumes that as light of suitable wavelength increases the conductivity of most gases, apparently by forming ions, this dissociation will probably give products (atoms or ions) one half of which will be positive and one half negative—whatever meaning may be attached to these words. If the dissociation products are ions, these words will have their usual meaning. To this assumption he adds four others that are partly new:—(2) That there is a slight reversible reaction between bromine and the positive gaseous ion,

$$Br_2 Br^+ \rightleftharpoons Br_2 + Br^+.$$

(3) That substitutions take place in the ring when the negative gaseous ions are present in excess; otherwise in the side chain. (4) That the addition products of benzene are to be considered as analogous to the chain substitution products of toluene. (5) That there is a reversible dissociation of the halogen carriers with formation of so-called gaseous halogen ions, and whether these ions are positive or negative depends on the nature of the carrier.

Granting these assumptions, at low temperatures and in the dark, $Br_2.Br^+$ will be formed, and therefore an excess of negative bromine ions and ring substitution. With rising temperature the proportion of positive to negative bromine ions increases, and sunlight will increase the dissociation of bromine and of the $Br_2.Br^+$, until the ratio of positive to negative ions approaches unity, and then side-chain substitution takes place. With reference to the fifth assumption, in chlorides of iron, antimony, molybdenum, and aluminium, there is no doubt that chlorine is the negative radical. In iodine monochloride, phosphorus pentachloride, and sulphur chloride, there is evidence of a tendency to form positive gaseous chlorine ions. The author remarks that "it would strengthen the argument if it were possible to show why negative chlorine substitutes in the ring and positive chlorine in the side chain, but I do not see any explanation which can be carried through." A weak point in the argument is the behaviour of aluminium chloride, which Goldschmidt and Larsen have found to behave exactly like stannic chloride as a carrier, although no lower chloride of aluminium is known. But, on the other hand, Turrentine has found evidence of its existence by the electrolysis of a chloride solution using an aluminium anode, though the aluminous salt has not been isolated. C. J.

## BAROMETRIC GRADIENT AND WIND FORCE.[1]

THE relation between the wind and the pressure distribution is a fundamental question of dynamical meteorology. In qualitative form it is expressed by Buys Ballot's well-known law that in the northern hemisphere an observer standing with his back to the wind has the region of lowest pressure on his left. The idea of a quantitative relation between gradient and wind has been made familiar to meteorologists by the classic researches of Guldberg and Mohn. It must, however, be admitted that a comparison of the wind velocity calculated from the pressure gradient by the method given by these authors with anemometer readings has not given entirely satisfactory results. The discrepancies are generally attributed to surface friction, but this quantity has not proved amenable to theoretical treatment, a difficulty which seems to have barred the way for further progress along these lines.

We should expect the effects of surface friction to decrease rapidly with altitude, so that the results of kite and balloon ascents should yield a more suitable material for a comparison of theory and observation than the observations at ground level do. In the report before us, Mr. Gold has used the data accumulated by the Prussian Aëronautical Observatory for such a comparison. From the distribution of pressure he has computed the gradient velocity over Berlin by the formula given by Guldberg and Mohn for each day of the year 1905, and has set beside it the observed direction and velocity of the wind at 1000 metres and 2000 metres above sea-level. The agreement at 1000 metres is surprisingly close. In the preface Dr. W. N. Shaw says of it:—"The general result of the investigation is, in my opinion, to confirm the suggestion that the adjustment of wind velocity to gradient is an automatic process which may be looked upon as a primary meteorological law, the results of which are more and more apparent as the conditions are more and more free from disturbing causes, mechanical or meteorological."

Cases of discrepancy between observed and calculated values may thus be regarded as exceptional, and their special investigation promises an interesting field for research. The observations of wind made at the surface may perhaps also be utilised in this manner if, as Mr. Gold suggests, we prepare a series of coefficients, applicable to the individual stations, which will enable us to allow for the disturbing effects of surface friction.

For work on these lines a simple means of calculating gradient velocities from pressure distribution is required, and a considerable section of the report is accordingly devoted to providing it. Tables have been constructed showing the gradient velocities corresponding with different distances between consecutive isobars on charts of certain specified scales in different latitudes, or, if we prefer it, we have in the frontispiece a convenient scale for reading off the values from the map of the daily weather report or the working chart of the Meteorological Office.

The tables and scale give the gradient velocity on the assumption that the isobars are straight, *i.e.* that the path of the wind is a straight line. If this condition is not fulfilled, a simple correction has to be applied from a second set of tables (or scale of concentric circles) to allow for the curvature of the path of the wind.

There is one point of principle which requires to be mentioned in this connection. In applying the correction,

[1] Report to the Director of the Meteorological Office on the Calculation of Wind Velocity from Pressure Distribution and on the Variation of the Meteorological Elements with Altitude. By Ernest Gold. (London: Wyman and Sons, for H.M. Stationery Office. Price 2s. 6d.)

it is assumed that the curvature of the isobars is identical with the curvature of the path. This is only true in the special case when the pressure distribution remains constant. If the curvature is small or the pressure distribution is changing rapidly, the difference between the curvature of the isobars and that of the path may be considerable, and the gradient velocity obtained by assuming them identical may be considerably in error. Unfortunately, the determination of the wind path is impossible under these special conditions, and the method of determining the gradient velocity then becomes untrustworthy. Mr. Gold optimistically extricates himself from the difficulty by suggesting a method for determining the motion of the centre of curvature from the difference between the observed velocities and the velocities calculated from the curvature of the isobars and the distance between them.

Two theoretical results arrived at by Mr. Gold are of special interest. He has calculated the time required for air, starting from rest, to acquire the gradient velocity and to adjust its motion to the direction of the isobars. The values found for latitude 50° vary between 4 hours and 16 hours for different conditions of motion, and are thus small compared with an interval such as the day. On another page he gives us an interesting counterpart to the well-known fact that strong winds and steep gradients do not occur near the centres of anticyclones. From the opposition of the accelerations due respectively to the earth's rotation and the curvature of the path, he shows that there must be a limiting velocity and a limiting gradient for anticyclonic areas, if it be granted that the motion of the air adjusts itself to the gradient velocity.

The concluding pages of the report are devoted to a graphic summary of the variation of the different elements with height, as disclosed by the ascents carried out on behalf of the Meteorological Office by Mr. Dines at Oxshott in 1906, and by ascents made at Lindenberg, Berlin, and Blue Hill Observatory, U.S.A.

There is one point to which we should like to refer before concluding. Nobody can take up a paper like the present one, which deals so largely with providing the tools for future research, without being forcibly struck by the disadvantages of our English system of units, at any rate for the purposes of dynamical meteorology. Mr. Gold invites us to measure the distance between isobars for intervals of a tenth of an inch in millimetres. The gradient velocity he gives us in metres per second, and provides a subsidiary table for converting these to miles per hour, the units adopted for wind velocity in all English meteorological publications, even in those specially devoted to the investigation of the upper air. He apologises for the incongruity in a special note, and explains it on the score of convenience. Should our would-be investigator require to chart his results, our map-makers will probably offer him outline maps on a scale of miles to the inch, and a further troublesome reduction will be necessary before he can apply Mr. Gold's tables. We note with pleasure that the maps used by the Meteorological Office for its working charts and daily weather reports are on a scale which is closely related to the natural scale $1:10^7$. We wonder whether other offices use similar scales. The advantage of uniformity in such matters is forcibly brought home by a report such as the one we have described.

## THE WORK OF THE PHYSIKALISCH-TECHNISCHE REICHSANSTALT IN 1907.

THE work accomplished by the Reichsanstalt last year, as shown by the annual report of that institution recently issued, appears to be of a character useful both to physicists and to the industries which seek its assistance in elucidating various technical problems.

As regards the physical side of the work, the following researches may be mentioned:—

In accordance with a commission received by the institution, tests were started on the exact measurement of very small pressures (of the order of between $10^{-6}$ and $10^{-3}$ mm.), the pressures being determined from the deflection of a metallic membrane of 25 cm. diameter by means of the Fizeau interference method. The absolute velocity of sound in dry air (free from carbonic acid) has been investigated and found to be $33192 \pm 5$ cm. per second. Dr. Scheel has tested some further materials for expansion between $-191°$ and $+16°$ C. with the Fizeau dilatometer described in the previous year's report, and has obtained results varying from 2120 microns per metre for palladium to $-41$ microns per metre for quartz glass. Scheel and Schmidt have obtained a much lower value for the refractive index of helium than that found previously by Lord Rayleigh and by Ramsay and Travers, the figures of the former being 1·0000340. Some useful work has been done in regard to the specific heat of nitrogen, $CO_2$ and water-vapour, up to 1400° C., and experiments to determine the saturation-pressure of water-vapour above 100° C. have been commenced.

In the Electrical Standards Department the variations in manganin resistances have been found to be very slight and the "humidity effect" only just perceptible. Resistance coils are now being wound on metallic spools with longitudinal slots to render them somewhat flexible; in this way it is hoped to make any effect due to humidity practically negligible. Measurements of the wave-length of electric oscillations can be made with an accuracy within 1 part in 1000 for long waves (above 1000 metres), and for shorter wave-lengths the accuracy is within 1 per cent. Other experiments have been made with undamped electric oscillations produced after the Poulsen method by means of an arc burning in oxygen. A research of importance to opticians was carried out in regard to the secular variation of the planeness of surfaces of optical glasses, results being given in the report.

In addition to the researches mentioned, a number of routine tests were carried out in the various departments of the Reichsanstalt, some of these yielding interesting results from a commercial standpoint.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MANCHESTER.—Dr. J. E. Petavel, F.R.S., has been elected professor of engineering and director of the Whitworth laboratories. The following additional appointments have recently been made:—Mr. T. G. B. Osbern, as lecturer in economic botany; Mr. C. H. Lander, lecturer in engineering drawing; and Dr. F. H. J. A. Lamb, senior demonstrator in physiology. Dr. Hans Geiger has been re-appointed to the Harling research fellowship in physics, and Dr. Harry Osborne has been re-appointed a junior research fellow in public health.

THE Department of Agriculture and Technical Instruction for Ireland has issued a circular to committees of management of schools dealing with the question of the liability of school managers and teachers in cases of accidents to pupils in attendance at their schools. In a recent action at law, damages were recovered from a teacher on account of injuries received by one of his pupils in consequence of a dangerous substance, used for scientific experiments, having been left carelessly in the way of his pupils. The department has been advised that teachers may be held accountable for the accidents which may occur as a result of allowing dangerous substances to be within the reach of children so young as to be likely to deal with them in a manner causing injury, or for injuries which may ensue as a result of negligence in allowing these pupils to perform dangerous experiments without providing reasonable safeguards against accident. The object of the circular is to make teachers aware of their responsibility so that all precautions may be taken to guard against accidents to their pupils. Fortunately, it is easily possible to devise suitable school courses of elementary science, including no experiments of a dangerous character, and it may be hoped that this timely warning may interfere in no way with the suitable study of science by boys and girls.

AN address on the teaching of the sciences and the formation of the scientific spirit was given by Prof. Paul Appell, president of the French Association for the Advancement of Science, at the meeting held last week at Clermont Ferrand. From a summary given by the Paris correspondent of the *Times*, we learn that Prof. Appell defines the man of science, not as "the man who knows," but as a man who "combines with his knowledge scientific activity, that is to say, a curiosity always alert, indefatigable patience, and, above all, initiative and again initiative." French instruction, he pointed out, was not generally calculated to develop the latter. The examination system was a trial of memory, not of real knowledge, observation, and experience. The evil extends from the primary schools to the upper special schools, and nothing is more necessary than to begin to oppose this tendency. Prof. Appell's solution would be to utilise universities for scientific education and to substitute for the technical schools, which are now virtually closed to many temperaments that might develop scientific capacities—even a Claude Bernard failed to pass his examination for the medical faculty—open schools in which the selection would take place from among the pupils according to the results of their work for the entire year. He would substitute for the two or three years now passed in the Lycée to prepare for the entrance into the upper special schools a course of scientific training immediately after the close of secondary studies. Prof. Appell developed an elaborate system of re-organisation of the universities involving a complete change in the curriculum of the Sorbonne and in the administration of the Museum of Natural History. He would not, however, in any way alter the character of the Collége de France.

THE Board of Education has issued (Cd. 4184) regulations for the training of teachers for secondary schools. Funds have long been available for the purpose of assisting the training of elementary-school teachers, but there has hitherto been little official recognition of the necessity of making some systematic provision for the professional training of men and women intending to teach in secondary schools. Now, however, a Parliamentary grant of 5000*l.* has been made available from the Exchequer for this purpose, and the regulations under which the fund will be dispensed are of great interest. The Board has decided that the course of training must be taken after graduation or its equivalent, and be confined to purely professional work. It is to be an indispensable condition for recognition as an efficient training college that there shall be access for the students, under proper conditions, to secondary schools which are thoroughly suitable for demonstration and practice, and not less than one-half of the staff must have been successful teachers for a reasonable time in secondary schools. Grants will be paid to colleges, in which the number of recognised students is not less than ten, at the rate of 100*l.* in respect of every complete group of five recognised students, subject to the condition that the grant does not exceed one-half of the total sum paid for salaries on account of services in training the students. It is satisfactory to find so complete an appreciation of the imperative need that the staff responsible for the training of secondary-school teachers must possess high academic qualifications, and be, in addition, experienced and successful teachers. There has been in the past an uneasy feeling that much of the training available for secondary-school teachers was divorced too completely from schoolroom practice and over much concerned with theoretical and historical matters, and these regulations of the Board of Education will serve to inspire greater confidence in the value of the training provided in assisted colleges.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, May 28.—"On the Theory of Capillarity." By Dr. E. T. **Whittaker**, F.R.S.

The fundamental quantities in the theory of capillary phenomena are the *surface-tension* $\gamma$ (expressed, say, in dynes per centimetre), and the *surface-energy* $\lambda$ (expressed in ergs per square centimetre). The relation between these two quantities is at once given by the thermodynamic equation connecting available energy with total energy; it is therefore

$$\gamma = \lambda + T\frac{d\gamma}{dT}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where T denotes absolute temperature.

This equation implies that when the area of a surface of separation is increased by 1 cm.$^2$ at temperature T, the external agencies do work amounting to $\gamma$ ergs against the surface-tension: and this energy, together with a further contribution of $-Td\gamma/dT$ ergs which is appropriated from the heat-energy of neighbouring bodies, becomes resident in the film, giving rise to an increase of $\lambda$ ergs in its internal energy.

The relation between the surface-tension and surface-energy is, of course, exactly the same as the relation between the electromotive force of a voltaic cell and the energy of the chemical reactions which occur in the cell.

The author has deduced the values of $\lambda$ which correspond to Ramsay and Shield's experimental values for $\gamma$, and shows that they satisfy a relation which may be stated as follows:—*The surface-energy $\lambda$ of a liquid in contact with its own vapour at any temperature is proportional to the product of the internal latent heat and the (absolute) temperature.*

The internal latent heat is intimately connected with Laplace's "intrinsic pressure" K of a liquid, and so with the classical theory of capillary phenomena.

### PARIS.

**Academy of Sciences**, August 3.—M. Bouquet de la Grye in the chair.—A problem relating to the theory of orthogonal systems and the method of the mobile trihedron: Gaston **Darboux**.—Contribution to the dynamical study of motors: A. **Witz**. If, when the motor has arrived at a state of steady motion, the motive power is instantaneously cut off, the moving parts make a certain number of revolutions with a decreasing velocity. From a study of this decreasing velocity important conclusions concerning the effects of friction can be obtained. The application of this method to a gas engine, working a dynamo, gave an efficiency of 79 per cent., as against 78·4 per cent. obtained by using the dynamo as the motor. For smaller gas engines the results were less satisfactory.—The families of Lamé composed of equal surfaces: J. **Haag**.—The tendency of material systems to escape friction: Georges **Rémoundos**.—Detectors for use in wireless telegraphy with points of tellurium and tellurides: Édouard **Branly**. The tripod detectors with points of tellurium or tellurides acting on polished steel belong to the group of radio-conductors working by variations of resistance, and require an external electromotive force for their working. The thermoelectric detectors of M. Tissot belong to a different class.—The conditions and duration of the auto-excitation of dynamos: M. **Swyngedauw**.—The electric arc between a solid electrode and a liquid: G. **Athanasiadis**. Duddell's experiment may succeed when the arc is produced between a liquid anode and a solid kathode. The arc formed between an electrolyte and a solid electrode as the kathode may be produced even with an immersion of 7 cm. or more, the difference of potential being 220 volts, and in certain cases this arc may give rise to the effects of the Wehnelt interrupter, although with reduced intensity. It is impossible to produce an arc between a solid anode and an electrolyte even with a voltage of 220 volts.—The quantitative indications furnished by dissociation spectra: silver: A. **de Gramont**. The number and intensity of the silver lines, obtained in the dissociation spectra of mineral conductors, bear a direct and constant relation with the proportion of the metals in the specimens. Details are given of the lines for various minerals and alloys containing from 1 per cent. to 0·0001 per cent. of silver, and application is made of the method to the study of argentiferous galena.—A new method of preparing pure hydrogen: M. **Mauricheau-Beaupré**. Aluminium foil is treated with a small quantity of mercuric chloride and powdered potassium cyanide. In contact with water this material gives 1300 c.c. of pure hydrogen per gram. Advantages are claimed for this material in aëronautics.—The realisation *in vivo* and *in vitro* of precipitins for ovalbumen: André **Mayer** and Georges **Schæffer**.

A precipitin has been obtained for ovalhumen by injecting certain fatty acids or their esters in the rabbit; this material possesses all the properties of that obtained by injecting the rabbit with ovalbumen.—The maturation of the egg and cytodiæresis of the blastomers of *Paravortex candii*: Paul **Hallez.**—Composition of the strata transported from the Peloponnesus to Mt. Ithoma: P. **Négris.** —The first twilight of the morning and the second evening twilight: E. **Durand-Gréville.** This phenomenon appears to be general, and is not peculiar to mountain districts, and hence an explanation cannot be sought in the cooling of the air in the mountain valleys.

### NEW SOUTH WALES.

**Linnean Society,** June 24.—Mr. A. H. S. Lucas, president, in the chair.—A catalogue of the Hemiptera of Fiji: G. W. **Kirkaldy.** The previous total of Fijian Hemiptera was about forty. This is brought up to 202 (of which seven have not been specifically determined), including the representatives of ten genera, one subgenus, and forty-two species described as new. But the endemic forms were scarcely yet collected, as only three islands had been searched for Hemiptera, viz. Viti Levu, the largest island and the seat of the present capital; Ovalau, a small island, the former seat of government; and Taviuni, an island to the east of Vanua Levu. The whole archipelago must be exceedingly rich in Hemiptera, and probably less than a tenth of the total of that fauna is known.—Revision of the genus Seirotrana (Coleoptera: fam. Tenebrionidæ), together with descriptions of new species of other Australian Coleoptera: H. J. **Carter.**—The new genus Austrogynacantha (Neuroptera: Odonata): R. J. **Tillyard.**

### CALCUTTA.

**Asiatic Society of Bengal,** July 1.—Proposals for a standard temperature for use in tropical countries: Paul **Brühl.** Specific gravity and other tables constructed for normal temperatures of 62° F. or 15° or 20° C. do not, as a rule, serve the purposes of the chemist and physicist who work in the tropics, and the spread of science in tropical countries will render the choice of one or two standard temperatures specially adapted to the tropics a matter of necessity. The author's observations lead him to the conclusion that the most convenient standard temperature for Calcutta is 30° C. at least during the period extending from the beginning of March until the middle of November. During the remaining part of the year 22° C. would be more useful as a standard temperature. Tables of the specific gravity of sulphuric acid at 25°, 30°, and 35° C. have been worked out.—Recent plant immigrants: Paul **Brühl.** A considerable number of phanerogamic species have found their way into Bengal during the last hundred years, and have become practically endemic. Some of them belong to the most common weeds found on road-sides and waste-places. One of the most recent immigrants is a species of Croton, which was first identified with *Croton sparsiflorus*, Morung, by Colonel Prain, who discovered the plant in the Sunderbuns. A detailed description of the plant is given; its present distribution is traced as far as possible. A list of those species is added which appear to have immigrated into Bengal during the last century.—Geological notes on Hill Tipperah (including the Lalmai range in Comillah district): Hem Chandra Das **Gupta.** This paper gives a sketch of the geology of a district about which little is known, except that the rocks are all of Tertiary age. The account of the tract called "pyaro land" is interesting, as it directs attention to a phenomenon not easily to be accounted for. It may be an area of local subsidence, set in motion by the earthquakes that have been so numerous in eastern Bengal during the past few years. —Drosometric experiments and observations: Paul **Brühl** and Bepin Behari **Das.** The fact that a great number of plants growing in Bengal continue to flourish during the drier seasons of the year, notwithstanding the absence of rainfall during several months, points to the dew playing an important part in Bengal plant life. The authors have, therefore, during the last three years, made a number of observations on the condensation of dew from the end of one rainy season to the beginning of the next. For this purpose they have constructed a dew-recording instrument, which is described. A selection of the curves obtained is added.—The surgical instruments of the Hindus, with a comparative study of surgical instruments of the Greek, Roman, Arab, and modern European surgeons. Part ii., Blunt instruments: Dr. Girindra Nath **Mukerjee.** The author describes at length the blunt surgical instruments mentioned by Susruta and other writers, and compares them with instruments known to the Greeks.—Observations on the intensity of daylight illumination in Lower Bengal: Paul **Brühl** and Bepin Behari **Das.**—The most complete set of observations on daylight illumination is that made by Prof. Leonhard Weber and his coadjutors in the Physical Institute of the University of Kiel. Some observations have also been made in the tropics, especially by Wiener in Java. The authors have collected corresponding data in the Physical Laboratory of the Engineering College, Sibpur, using a Weber's photometer as the observing instrument and a large screen of plaster of Paris for the illuminated surface. The results have been tabulated.—Reduction of Fehling's solution to metallic copper—a method of depositing a shining, mirror-like film of copper on glass vessels: Panchanan **Neogi.**

## CONTENTS.

THURSDAY, AUGUST 20, 1908.

## HEREDITY.

*Heredity.* By Prof. J. Arthur Thomson. Pp. xvi+605. (London: John Murray, 1908.) Price 9s. net.

WE all know books on science which we ought to read with pleasure, but to which we turn with shrinking. Full, perhaps, of new facts and ideas, they are so expressed as to bore consumedly. "Heredity" belongs to another category. He who runs may read, even if he be a beginner, and he who reads will probably not cease to run until he has traversed the last page. It contains nothing very new, but most of the facts on which we found our notions of heredity are set out lucidly and in orderly array, as are almost all the theories ever based on them. It is dedicated to "Francis Galton and August Weismann, whose magistral studies on heredity have made us all their debtors." Prof. Thomson is very loyal to the masters.

The outstanding feature of the book is its great, perhaps its excessive, kindliness and toleration. Probably few biologists agree so thoroughly with so many of their fellows as the author. Practically the only hard things he has to say are about "hereditary tendencies" and "principles of heredity," which seem to him "in part the old story of explaining the working of the clock by 'principle of horologity' and in part a pedantic way of saying 'we don't know.'" But for many years no serious student of science has used the word principle except as a synonym for that brief and comprehensive summary of facts which is otherwise termed a "law." We speak of the "principles of psychology," the "principles of geology," and so forth; and surely the germ of a mouse develops into a mouse, and not into a beetle, because it has, among other things, a tendency, a "predisposition" to do so. "Predisposition" is, oddly enough, approved by Prof. Thomson, who pronounces predispositions to be "mysterious" but not "mystical." No doubt they are quite as mysterious but not more mystical than eyes and noses.

The book has many merits, not the least of which are its comprehensiveness and literary charm. Its principal defect is lack of that "rigorous deductive inference of consequences" by means of which we link together and test hypotheses and so ascertain whether they are in harmony with one another and "with the conceived system of reality." It is not sufficiently critical. Theories, even when incompatible, are set out with an appreciation that is equally cordial. The law of ancestral inheritance, the theory of the continuity of the germ-plasm, and the theory of recapitulation are conspicuous examples. A statistical inquiry led Galton to the conclusion that, on the average, progeny resemble progenitors in certain degrees, whence he drew the deduction that the heritage of descendants is compounded in the stated proportions of ancestral contributions. I have ever been doubtful of the precise meaning of the term "contribution," but apparently it implies more than mere resemblance, or it would not be used. Readers of "Heredity" will be sure to conceive a contribution as an actual something contributed to the germ-plasm by the progenitor.

Passages like the following abound:—"We know . . . that the parental heritages include ancestral contributions which may be expressed in development or lie latent." But this notion will be hard to reconcile with the idea that "the parent is rather the trustee of the germ-plasm than a producer of the child." If, however, readers elect to regard "contribution" as synonymous with Weismann's "ancestral plasm" (a collection of determinants similar to that which controlled the development of the ancestor), they will be puzzled to reconcile the statement that "an individual inheritance is a mosaic of parental and ancestral plasms" with the theory that "the individual development, especially in the stage of organ-forming, is in some measure a recapitulation of the racial history," a theory which represents ancestral contributions, not in the form of a mosaic, but in that of a series. Must we assume, then, that the remote ancestors, in whom the organs were evolved, contributed to a series, but more recent ancestors to a mosaic; or is it the right view that, since the characters of the organism vary independently, retrogression in some characters, combined with progression in others, produces, in part at least, the *appearance* of a mosaic?

Every generation follows more or less closely in the developmental footsteps of the preceding generation, and every progressive variation prolongs development by adding itself to the sum of those already made and preserved during phylogeny. Of course, therefore, development is, with large reservations, a recapitulation of the life-history. Preservation (*i.e.* reproduction) implies recapitulation. Presumably the germ-plasm can lose as well as gain; that is, failure to complete the recapitulation of the parental development in any particular may be due to true variation, not merely result from injury received during development as Prof. Thomson seems to imply. Suppose an individual varied in such a way as to lapse the progressive variations of many ancestors; then, as regards the character in question, he would be in the position of a more or less remote ancestor. Is this reversion? If not, why not? According to Prof. Thomson only the reappearance of a latent character constitutes reversion. He would find it hard to justify his position.

He insists, as others have done, that "filial regression has nothing to do with reversion," because "there is a levelling up as well as a levelling down." But the fact, admitted by him, that cessation of selection tends to be followed by retrogression, indicates that on the whole there is a greater tendency to level down than to level up. In other words, retrogressive variations tend to predominate over progressive variations. If, then, development is modified recapitulation, it is plain that filial regression has something to do with reversion. At any rate, the attempt to link the two together is not necessarily due to misunderstanding. Doubtless regression is not always a "biological term," but when we speak of filial regression it is.

He gives full weight to the question of the transmission of acquirements, but declares that "some subtle minds have found satisfaction in maintaining that the distinction between an acquired modification and an inborn variation is a distinction without a difference." He is mistaken. It has been maintained merely that the erroneous terms "innate" and "acquired" obscure rather than reveal the very real and immensely important difference between the two classes of characters.

He discusses the Mendelian experiments which demonstrate that in certain cases descendants tend to reproduce the unlike characteristics of ancestors in the well-known proportion, and alludes to the "increased subtlety of Mendelian interpretation." The facts are compatible with a theory of segregation or with one of latency of the recessive in the pure dominant, and *vice versâ*. He does not mention, however, the crucial instance of the reappearance of latent ancestral characters in *pure-bred* varieties in which can have occurred no re-union of previously separated colour (or other) factors.

One of the principal topics discussed is the question of the causation of variations. The evidence is that some are due to the direct action of the environment (nutriment, toxins and the like) on the germ-plasm, while others are spontaneous in the sense that they result from a tendency to vary as much inherent in the germ-plasm as its tendency to grow and divide. But what is the origin of the great mass of variations, those on which racial change is founded? If variations are *usually* caused by direct action, then a human race, constantly exposed to a virulent toxin (*e.g.* that of malaria) or to such a complex of ill-conditions as that found in the slums of great cities, should deteriorate steadily. Natural selection could have no scope, for every generation would be inferior to its predecessor. The race would drift helplessly. If, on the contrary, variations are, with rare exceptions, spontaneous, and occur all round the specific mean, natural selection has scope, and every race, or section of a race, tends to become resistant to the ill-conditions to which it is exposed. Prof. Thomson holds the first opinion, and draws his arguments mainly from medical sources. From time immemorial doctors have attributed all sorts of filial and racial degeneracy to all sorts of parental mishap. Lately, however, a rapid change of opinion has occurred, as may be seen by examining the report (just published) of the Royal Commission on the Care and Control of the Feeble-minded. The Commission follows Sir E. Ray Lankester, who declares that "no facts are known which support these imaginative teachings." Alluding to the rather widely known fact that every race is resistant to every ill-condition precisely in proportion to the length and severity of its past experience of it, it declares that "It is not to be conceived that a race which deteriorates in every generation can emerge from the struggle not weakened, but strengthened." In truth, the hypothesis that variations are usually due to direct action is wholly incompatible with the theory of natural selection, which, nevertheless, Prof. Thomson upholds. If additional evidence be needed it is furnished by plants, which, when propagated asexually and taken to all climates of the world, hardly vary until the first seminal generation, and then not more apparently than if no such long and diverse exposure of the germ-plasm had occurred. Obviously variations occur normally precisely when they are useful—at the genesis of a new individual when they furnish materials for natural selection. It seems reasonable to conclude, therefore, that they are under the control of natural selection, a superior or inferior tendency to vary being in itself a variation liable to selection. This hypothesis is strongly confirmed by the fact that retrogressive variations tend to predominate over progressive variations—an immensely useful tendency, for, while useful variations and structures are preserved by natural selection, useless variations and structures are planed away without elimination of individuals.

When cultivated in non-living media, the parasitic microbes of disease gradually lose their virulence, which is nothing other than the means by which they protect themselves from the cells of the body. Non-virulent saprophytic micro-organisms, introduced under fit conditions into the living body, gradually acquire virulence. In the one case, apparently, retrogression follows cessation of selection, in the other progression follows selection. The widely accepted hypothesis that microbes "acquire" and transmit virulence in the Lamarckian sense is demonstrably untenable. How could the direct action of the environment on the bodies of the microbes cause them to "acquire" the mechanism necessary for the production of such adaptive and elaborate chemical compounds as toxins? Presumably all parasitic microbes have evolved from saprophytic types. Men have made the microbes of human diseases virulent, and each human disease has made the race exposed to it resistant to itself. While races (*e.g.* British and Negro) which have evolved in conjunction with their familiar diseases (*e.g.* tuberculosis and malaria) are able to persist when exposed to them, other races (*e.g.* Polynesians and Red Indians) tend to perish. Disease supplies the only instance in nature in which we are able to see natural selection actually at work, and the study of diseases reveals a multitude of very beautifully adjusted and unmistakable adaptations. The facts are not disputed; the inferences, I believe, are indisputable. Prof. Thomson thinks, however,

"It would be a subtler and more convincing line of argument to say that, throughout the ages, man has been selecting the microbes, lessening the virulence, in a sense taming them—sometimes to death—as his phagocytes were strengthened by more suitable food, or as his 'opsonic' index improved, again also in relation to food."

He means that man has somehow selected the weaker, the less protected, of his persecutors for survival, that his present food would have been more suited to his ancestors than that which evolution fitted them to consume, and that negroes are more resistant than Englishmen to malaria because they are better fed, Englishmen more resistant than negroes to tuberculosis for the same reason, and Polynesians less resistant than both races to a multitude of diseases because they are worse fed.

G. ARCHDALL REID.

## EGYPT AND BABYLONIA.

*Egypt and Western Asia in the Light of Recent Discoveries.* By L. W. King and H. R. Hall. Pp. viii+480; illustrated. (London: Society for Promoting Christian Knowledge, 1907.) Price 10*s*.

THIS handsome volume from the pens of Messrs. King and Hall, of the British Museum, is intended as a supplement, or, as the authors modestly express it, "an appendix or addendum," to include all the most recent results of discoveries in Egypt and Western Asia, and thereby bring up to date the three volumes of Prof. Maspero on "The Ancient History of the Peoples of the Classic Orient," which the Society for Promoting Christian Knowledge issued between 1894 and 1896.

The period since the last volume of Prof. Maspero's history appeared has been one very rich in discovery, and archæologists have been busy with the spade in the Greek islands and mainland, in Asia Minor, the Euphrates and Tigris valleys, as well as in Egypt and Nubia, with most startling results. In 1894 we were almost in the dark as to Egyptian history prior to the time of Snefru, the last king of Manetho's Third Dynasty, and prehistoric Egypt was practically unknown. The so-called Minoan civilisation of Crete was undreamt of, and hardly anything was known about the early peoples of Syria and Asia Minor. Now, thanks mainly to the work of M. de Morgan, Prof. Flinders Petrie, Dr. Arthur Evans, and Prof. Winckler, we can extend our vista far beyond the horizon of 1896.

It is with the discovery of prehistoric Egypt that the volume before us opens, and here the authors bring together the latest results of the explorer in the field of prehistoric antiquities in the Nile Valley. They finally dispose of the old theory maintained by Petrie and Blankenhorn that the desert plateaus on both sides of the valley were in Palæolithic days clothed with forest, and they bring forward the more reasonable one promulgated by Beadnell that the torrents which are sometimes experienced in the desert at the present day would have been enough to have cut out the deep ravines or *wadis* in the limestone rock such as we see at Thebes in the famous ravine called the Valley of the Tombs of the Kings. Whether Palæolithic man in Egypt—where he is represented by thousands of flint tools from the desert plateaus—was contemporary with the Cave man of Europe we do not know; nor are there any data whereby even a rough estimate can be made as to when the Palæolithic period was succeeded by the Neolithic. For a considerable time anterior to the First Dynasty, copper as well as stone weapons were in use, so that even before the beginning of the historical age the Egyptians were living in the "Chalcolithic" period. The beginning of the Dynastic age is placed by Messrs. King and Hall at about 4500 B.C. (p. 13), but this does not at all agree with the latest researches into the vexed question of Egyptian chronology, which tend rather to diminish than to lengthen out the hitherto accepted chronology. A most important monograph on this subject was written by Prof. Eduard Meyer in 1904, and is printed in the *Abhandlungen* of the Konigl. Preuss. Akademie der Wissenschaften (with a *Nachträge*, 1908); but this the authors do not seem to know, nor do they refer to Prof. Breasted's concise summary of the facts relating to Egyptian chronology in the first volume of his "Ancient Records." A perusal of Meyer's or Breasted's works will show that there is very good reason for placing the beginning of the First Dynasty at not earlier than about the year 3500 B.C.

Regarding the question as to the origin of the Egyptians, Messrs. King and Hall point out that in the early dynastic period two races lived in Egypt which differed considerably in type and also in burial customs. The Dynastic people, they believe, came originally to the Nile Valley from the shores of the Red Sea by way of the Wady Hammamat, to Koptos and Kûs.

"From many indications," they say, "it would seem probable that these conquerors were of Babylonian origin, or that the culture they brought with them (possibly from Arabia) was ultimately of Babylonian origin."

The Lower Egyptians, who were conquered by the Dynastic race, were possibly of Mediterranean stock, akin to the primitive inhabitants of Palestine, Greece, Italy, and Spain.

The second chapter deals with Abydos and the first three Egyptian dynasties, but the authors do not appear to have any very clear idea as to the real history of this early period. On p. 73 it is said that the "King Sma" is "possibly identical with Aha or Narmer, more probably the latter." There is, in fact, no evidence whatever that Sma is the name of a king or even of a person at all, while, on the other hand, it is a well-known title meaning "consort," and was often assumed by queens. On pp. 61–62 it is said that Narmer is not represented at Abydos, yet at least half-a-dozen monuments bearing his name have come from there. There has been much discussion as to the validity of Dr. Borchardt's identification of King Aha with Menes, the traditional founder of the monarchy; Messrs. King and Hall dismiss the subject by saying (p. 76): "Whether Aha was called Men or not it seems evident that he and Narmer were jointly the originals of the legendary Mena." The nomen of Khasekhem, we note, is given as "Besh," but this is very doubtful; the name of the last king of the First Dynasty is transliterated everywhere as Qa, whereas, surely, the right reading is Qa-a, "the high of hand."

In the third chapter the authors discuss recent discoveries relating to Memphis and the Pyramids, and advance the theory that the city of Memphis was built by Merbapa, the Miebis of Manetho's list, and not "by the legendary and confused Mena." In support of this it may be noted that Merbapa heads the list of kings of the Sakkara Canon.

The fourth, fifth, and sixth chapters are devoted to an account of recent research in Western Asia, and are important as giving a summary of all the latest results achieved by explorers in the valleys of the Tigris and Euphrates. The authors repeat the view recently brought forward by Mr. King that the first Babylonian dynasty was in part contemporaneous with the second, and that the latter consisted of Sumerian kings who had established themselves in the Sea Country. This contemporaneity of the first and second Babylonian dynasty, of course, brings down the chronology of Babylonian history, and this fact must henceforward be borne in mind by Egyptologists, for there are several synchronisms between Babylonian and Egyptian history which have been well established. The authors deal in the sixth chapter with early Babylonian life and customs, and this is certainly the most interesting part of the book. Since Prof. Maspero wrote his history, two new sources of information have been made available which have greatly increased our knowledge of the constitution of the early Babylonian State, and of the conditions of life of the various classes of the population. The most important new source is the great Code of Laws drawn up by Hammurâbi for the guidance of his people, and defining the duties and privileges of all classes of his subjects. This was discovered by M. de Morgan at Susa, and is one of the most remarkable documents that has ever fallen to the lot of an excavator to unearth. The other new source of information consists of a series of royal letters written by kings of the First Dynasty to the governors and officials of various great cities in Babylonia. These tablets are now preserved in the British Museum, and the range of subjects with which they deal is enormous, and, as the authors say, "there is scarcely one of them which does not add to our knowledge of the period."

The three last chapters are devoted to the most recent discoveries in connection with the history of the later periods of the Egyptian and Assyrian Empires. A good summary is to be found here of all the latest finds at Thebes, including those in the Valley of the Tombs of the Kings, which have so enriched the National Museum at Cairo.

## *POTENTIAL ENERGY AND THE FIGURE OF THE EARTH.*

*Das mechanische Potential nach Vorlesungen, von L. Boltzmann bearbeitet*, und *Die Theorie der Figur der Erde, zur Einführung in die höhere Geodäsie*. By Dr. H. Buchholtz. Erster Teil. Pp. xvi+470. (Leipzig: J. A. Barth, 1908.) Price 15 marks.

AN intimate knowledge of the theory of potential energy is of undoubted value to the student of theoretical geodesy, and it is with this object that Dr. Buchholtz has given us in this book a complete and exhaustive treatise on the subject since its inception by Newton down to the present day. But it is not alone to those interested in the complex study of the figure of the earth that this portion of the book will appeal; for in the application of the potential theory, not only is gained a knowledge of some of the most elegant mathematical theorems, but at the same time a deep insight into nature is obtained.

It would be difficult to over-estimate the excellent treatment of the subject by Dr. Buchholtz, who in his preface acknowledges his debt of gratitude and inspiration to his former teacher, the late Prof. Boltzmann, to whom is due a great number of the explanations and theorems met with in the book.

The author takes his reader through the whole history of the subject, and the demonstrations and mathematical proofs are very clearly put. Indeed, it is the clearness and fulness of the several mathematical steps, which are so often omitted in treatises of this nature to the consequent disappointment and discouragement of the majority of students, that make the book so generally attractive.

After giving the necessary definitions and explanations of the various terms and formulæ due to all the learned philosophers who have made this subject their particular study, Dr. Buchholtz completes the first portion of the book with two very able chapters on the theory of the attraction of the ellipsoid and the potential of the La Place spheroid. In both chapters nothing has been omitted which could help the student fully to understand the complexity of this difficult question.

In the second portion of the book, which deals with higher geodesy, Dr. Buchholtz has been content to follow closely on the lines adopted by Col. Clarke in his "Geodesy." Nothing, indeed, could be more flattering to the famous English geodesist than the full use he has made of his work, from which nearly all the numerical examples dealing with the subject have been taken in their complete form.

Dr. Buchholtz, however, does not give an historical account of the various geodetic enterprises which have supplied the data for the solution of the many problems introduced, and which form by no means the least attractive portion of the English work.

The two chapters which make up this second portion of the book are confined to pure theory, but let it be said at once that the treatment is most thorough and complete, and the mathematical proofs extremely clear and easy to follow. In this respect the book is much more one for the beginner than Clarke's.

The first chapter gives a sketch of the classical theories of the form of the earth; and the various proofs by Clairant and La Place, which are of great historical interest and on which are based their respective important theorems, are fully treated. This is especially the case in the sections dealing with the well-known formula for the value of gravity at any latitude, with La Place's law of density and the deduction from it, and the observed constant of precession of the earth's ellipticity. The determination of the figure of the earth as a form of equilibrium is also fully dealt with in this chapter.

The second chapter is devoted to the calculation of distances, azimuths, and triangles on the spheroid and to "geodetic lines." It is chiefly taken from Clarke, and indeed a large portion of it is a literal translation of this work. In the matter of dealing with "geodetic lines," Dr. Buchholtz has given a far more exhaustive discussion than is to be found in most books on geodesy, the section dealing with the geometrical properties of the geodetic being excellent.

On the whole, the book should fulfil the wishes of the author—to supply a long-felt want in the German language in the shape of a short treatise on higher geodesy—though, as explained by Dr. Buchholtz in his admirable preface, many important and recent acquisitions to our knowledge of this subject have not been treated in the present volume, and remain to appear, we may hope, in a further contribution from the author.

It remains to mention that the whole book is excellently supplied with diagrams for the help of the student. W. J. J.

## ELEMENTARY SCIENCE.

(1) *The Principles of Physics.* By A. P. Gage. Revised by A. W. Goodspeed. Pp. viii+547. (Boston and London: Ginn and Co., n.d.) Price 6s. 6*d*.

(2) *Die Elektrizität als Licht und Kraftquelle.* By Dr. P. Eversheim. Pp. viii+121. (Leipzig: Quelle and Meyer, 1907.) Price 1.25 marks.

(3) *Elementary Science for the Certificate Examinations.* Edited by W. Briggs. Introductory Section. Pp. iv+256. Price 2*s*. 6*d*. Section A, Chemistry. Pp. vii+192. By H. W. Bausor. Price 2*s*. Section B, Physics. By John Satterly. Pp. viii+352. Price 3*s*. (Cambridge: University Tutorial Press, 1908.)

(1) THIS is a revised edition of a book which appeared in 1895, and the plan has been considerably altered in order to bring it into line with modern requirements. Sections have been omitted which in the opinion of the reviser are of little use to elementary students. These omissions consist chiefly of experiments to be performed by the student and the more remote applications of principles. New sections have been added describing in an elementary way the results of recent researches and practical applications. The plan adopted throughout the book has been to avoid so far as possible proofs of mathematical formulæ, and to explain the principles by experimental and descriptive methods. The first 150 pages are devoted to the subject of experimental mechanics. Sound, heat, light, including the elementary parts of interference, diffraction and polarisation, and electricity and magnetism form the rest of the volume. The statement on p. 229 is evidently an error, viz.:—

"Since liquids must be contained in a vessel of some sort the *observed* expansion is usually not that of the liquid alone, but a value *greater* than the real expansion of the liquid by the increase of volume of the vessel."

Again, on the same page india-rubber is cited as having a negative coefficient of expansion. An example of this kind should certainly be avoided with elementary students, the apparent contraction when heated being due to change in the elastic constant. The statement in italics on p. 278 is likely to confuse an elementary student, viz. "The illuminating power of light diminishes as the square of the distance from the light source increases." "Intensity of illumination" is better, "illuminating power" being regarded as a constant for the source of light.

The book is very well printed, and the illustrations are clear. It may be safely recommended to students who take up physics as part of their general education.

(2) "Elektrizität," by P. Eversheim, is a small book describing some of the present-day applications of electricity. It is intended for the general reader, or for those who have only a very slight acquaintance with the elementary facts of electricity.

The author first describes the various methods by which a current of electricity may be produced, and then proceeds to explain the phenomena of electromagnetic induction and the principles of the dynamo and motor. Practical applications are then dealt with, the subjects treated including electric lighting and various types of lamps, transmission of power, the electric telegraph, cable telegraphy, the telephone, electric waves, and wireless telegraphy.

As a rule, the explanations of phenomena are clear and accurate, and should be intelligible to the general reader, but the diagram on p. 9 will not give him a correct idea of the magnitude of thermoelectric currents, viz. a single couple with junctions at 0° and 50° joined to an ammeter reading one ampere. Again, in a book of this size one cannot expect full historical treatment, but the omission of the name of Faraday from the chapter on electromagnetic induction cannot be passed over without comment, especially when that of Lenz is included.

In Fig. 56, p. 113, "Braun" system of wireless telegraphy, the "earth connection" is in the wrong place. The "Aërial" should be earthed. In Fig. 58 the "earth connection" or "balancing capacity" are omitted. At the end of the book is a short section referring the reader to larger treatises on the subject of electricity and its applications.

(3) These three manuals comprise a course in elementary science suitable for the certificate and preliminary certificate examinations for 1909. The introductory section deals with the elementary measurement of length, area, volume, mass, density, &c.; properties of matter; thermometry and expansion; nature and composition of air and water; action of acids on metals, and of heat on some organic substances. The fundamental facts are well illustrated throughout by simple experiments to be performed by the student.

Section A is a further continued course in chemistry. The properties and interactions of some common substances are dealt with experimentally, and the fundamental laws of chemistry explained. The author has avoided formulæ and equations of reactions so far as possible in the text, introducing them in an appendix at the end.

Section B is a continuation of the physics course; mechanics, heat, light, electricity and magnetism are dealt with, the facts being well illustrated by simple laboratory experiments. The explanation of multiple reflections from thick mirrors avoids a very common error usual to text-books, but it is not true to say that all the images are on the normal to the mirror through the object. Fig. 33, p. 337, is misleading if intended to illustrate the probable result of the experiment numbered 37.

## OUR BOOK SHELF.

*The Sanitation of Recreation Camps and Parks.* By Dr. Harvey B. Bashore. Pp. xii+109. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1908.) Price 4s. 6d. net.

This small work may be read with interest and profit by those who camp out, and also by those who, for motives of sport, &c., roam about country districts. The sanitation of military and labour camps is not dealt with, but the author occasionally makes military experiences his text for the need of the sanitary precautions which he impresses. The sanitary rules advocated for camps embrace the careful screening of food from flies and dust until it is consumed; the avoidance of all brook or creek waters for drinking purposes, unless a careful survey has been made of the source of the brook or creek, and this has disclosed no access of harmful pollution; the daily burning or burying of all waste, solid and liquid; the desirability of carefully selecting a special area for the disposal of fæces, the exclusive use of this particular area, and the prompt covering of all dejecta by "mother earth." In districts where mosquitoes are troublesome and dangerous, adjacent brooks or pools should be treated with kerosene every ten days, and weeds and grass kept short around the camp.

The work is well illustrated, and by the avoidance of technical terms and the presentation of the subject in an interesting and pleasing style the writer has provided a most readable and useful little work. One of the occasional digressions to be noted makes reference to the very common practice in towns of exposing food to view in public places, without any protection whatever from the gross contamination involved in street dust. Certainly the practice cannot be defended; from the hygienic standpoint it is dangerous; to the contemplation of the refined it is disgusting; and from the commercial standpoint it is wasteful, for it must lead to a far quicker deterioration of the article than would take place if food were properly protected by glass.

*The Eye, its Elementary Anatomy, Physiology, and Optical Constants.* By Lionel Laurance. Pp. 100. (London: The Orthos Press, 1908.)

This little book, according to its preface, has been written for students in optics, and the author guarantees the precision of the facts therein contained on the ground that Mr. Lindsay Johnson has passed the proofs. The anatomy of the eye is fairly well described, but we cannot say as much for the physiology. On p. 21 we learn that "the visual purple, which is quite sufficient to enable one to see in bright sunshine, is altogether inadequate to see in a dim light. It is found that . . . none is found at the fovea. The function therefore of the purple appears to be to enable one to see better in a dim light." The definition of the angle $\alpha$ is erroneous; the angle described is that termed $\beta$ by precise ophthalmologists. The estimation of distance is due very little to the function of accommodation, but almost entirely to that of convergence, as can very easily be proved.

The subject of colour-blindness is indifferently well described, as no mention is made of Dr. Edridge-Green, although some of his results have been given. Students of optics will have much to complain of in the last ten pages of the book on optical constants. No proper use is made of algebraic signs; thus the anterior and posterior focal lengths of a refracting system are both expressed by the same sign, so that they both apparently lie on the same side of the system. Again, the focal length of the lens of the eye is measured from its surface, a correction having been introduced for its thickness; yet in the calculation on p. 90 the value assigned to $F_c$ should be the principal focal distance measured from the corresponding principal point.

*Before Adam.* By Jack London. Pp. 308. (London: T. Werner Laurie.) Price 6s.

In Mr. London's story a man has persistent dreams, in which he sees "visions of myself roaming through the forests of the younger world; and yet it is not myself that I see, but one that is only remotely a part of me, as my father and my grandfather are parts of me less remote. This other self of mine is an ancestor, a progenitor of my progenitors in the early line of my race, himself a progeny of a line that long before his time developed fingers and toes and climbed up into the trees. . . . An instinct is a racial memory . . . there must be a medium whereby these memories are transmitted from generation to generation. This medium is what Weismann calls the germ-plasm. It carries the memories of the whole evolution of the race."

Mr. London's theory of heredity is out of date. Nevertheless his book is extraordinarily vivid and convincing, and altogether delightful. Admirable as fiction, it is also, by virtue of good psychology and imaginative insight, in its way an inspiring work of science. Reading it, one finds it hard not to believe that our very distant ancestors lived just such a life as Mr. London portrays—full of intense but transient emotions, replete with danger and terror, but replete also with joys half human and half brute.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

### Bimetallic Mirrors made by Electro-deposition.

Apropos of Mr. Cowper-Coles's exhibit at the recent soirée of the Royal Society of metallic searchlight reflectors made by the electro-deposition of copper upon a silver film chemically deposited on glass, it may be interesting to mention that some forty years ago (I think in the year 1865) I spent a considerable time in experimenting in the same direction. My object was to make a true "flat" for the second reflection of a Newtonian telescope, with silver surface as bright as that in contact with silvered glass and without degradation from the true figure of the glass. The last condition I was unable to fulfil. It had been rightly judged that the outside surface of the silver film used by M. Foucault could scarcely have the truth of figure or the brilliancy of polish of the glass on which it had been deposited, hence the desirability of the object sought.

However firmly and closely the silver film had adhered to the glass, the moment the copper deposit commenced upon it it became detached from the glass owing to the contraction of the copper, and the surface which had been plane became convex.

This convexity seemed to be much the greatest in the usual sulphate of copper solution, with free acid, giving a tough deposit. With one containing little or no free acid and giving a crystalline deposit little contraction took place and the face continued fairly flat, but, of course, the process was tedious in the days of Daniell's cells, and I doubt if I ever obtained a true enough surface for my purpose.

The problem, however, which Mr. Cowper-Coles has set himself is a very different one. Extreme accuracy of figure is relatively of smaller importance, and with the devices of rotation of mirror and continual agitation of the solution, which, I believe, he has resorted to, and the latter of which I found much improved the results, he may arrive at a figure nearly as good as that of the matrix, of rather greater focal length, it may be, but nearly equally lengthened in all its parts. ROSSE.

Birr Castle, Parsonstown, August 14.

### The Form of a Dirigible Balloon.

ALTHOUGH it is not likely that dirigible balloons will be of much practical value except for purposes of amusement and to a limited extent for military observations, it seems a pity that the designs of such as are made should not embody existing knowledge as to the conditions which govern the resistance and stability of submerged bodies.

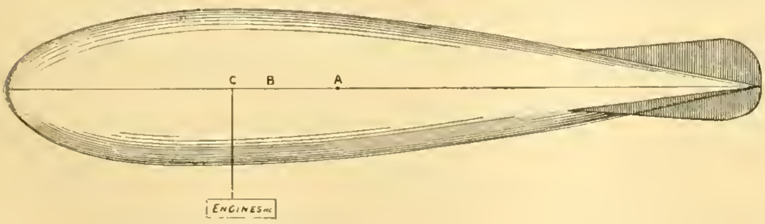
The resistance of a submerged body is a far less complex quantity than the resistance of a ship (inasmuch as no question of surface waves is involved), and can be stated simply as the sum of the resistances due to surface friction and wake, both of which vary very nearly as the square of the speed.

The surface friction resistance cannot be reduced below a certain limit, for the surface exposed cannot be less than the surface of a sphere which will hold the required volume of gas.

The wake or eddy-making resistance can, however, be very largely reduced by giving the balloon a shape gently tapering towards the stern, a shape which is adopted by all animals (birds, fish, whales, seals, &c.) the habits of which require them to move rapidly as submerged bodies.

The shape of the head of the balloon does not matter much so long as the profile is a fair curve. The important thing for reducing the wake is that from some position in front of the maximum diameter of the balloon the radius of curvature of the profile should increase, slowly at first, but continuously, towards the stern.

With regard to stability, it should be borne in mind that a submerged body, whether a sphere or elongated surface of revolution, is naturally unstable when moving in air or other real fluid, and will not without guidance continue to move in a straight line owing to the instability of the motion of the wake.




A, Centre of gravity of balloon. B, Centre of buoyancy of balloon.

This form of instability may be got rid of by providing small fins near the stern the planes of which contain, or are parallel to planes passing through, the axis of figure of the body.

Their number must not be less than three, but there is no objection to a greater number except on the ground of extra surface friction.

In the accompanying sketch a form is shown which would be suitable for a dirigible balloon so far as resistance and stability are concerned.

If it is assumed that the total lifting power of such a balloon is to be 2000 lb. (including its own weight), its capacity must be something under 30,000 cubic feet, and if the length is five times the greatest diameter, its dimension will roughly be :—diameter, 30 feet; length, 150 feet; and superficial area, 7000 square feet.

The surface-friction resistance at twenty miles an hour will require less than 2 horse-power. I have no data for the eddy-making resistance of such a form, but it would probably be less than half that of the bolster-like shapes generally adopted, which are hardly less resistful than a flat end would be (this applies to the stern only, not to the head).

The framework necessary to give the balloon the shape figured in the sketch would undoubtedly add to the dead weight, but would more than "pay for its carriage" by lessening the resistance, and thus allowing of the use of lighter engines, and I think that perhaps the most valuable part of Count Zeppelin's work has been to show that it is practicable to construct a balloon the shape of which is moulded by internal frames. A. MALLOCK.

6 Cresswell Gardens, S.W., August 12.

### The "Sky-coloured Clouds" or Twilight Glows.

THERE can, I think, be no doubt that the numerous descriptions which have appeared of the recent twilight phenomena relate to essentially the same phenomenon as the "sky-coloured clouds," or, as the late O. Jesse called them, the "luminous night-clouds." On June 30 and July 1, which seem to have been the principal dates, I was unfavourably situated for observing the phenomenon, but I may point out that I directed attention to it in your issue of June 11, p. 127.

The displays that have been noted in former years have been marked by a very striking appearance as of cirrus clouds, only (as O. Jesse ascertained) at a much greater altitude, viz. fifty-one miles. From the descriptions this year the cirrus-like appearance has evidently not been so well marked, although it is mentioned by some observers, and I noticed it myself (partly here and partly in Scotland); but sometimes the aspect of the light was uniform, and not striated like cirrus. In former years I have also sometimes observed the same when there was evidently a tendency to the formation, and yet the clouds did not appear, but only the luminosity. M. Félix de Roy, in the *Gazette Astronomique d'Anvers*, No. 8, p. 63, is of opinion that this year the phenomenon was not the same as that investigated by O. Jesse, but he calls it an "extraordinary twilight." In either case, no doubt the cause is essentially the same—*i.e.* reflection—some substance being at such a height in the atmosphere that the sun can shine upon it when far below the horizon of the observer. The coloration, although varying in intensity on different occasions, is also the same in either case, viz. red or red-orange near the horizon, gradually changing through orange, yellow, and green to blue above. This is the ordinary coloration of a clear twilight sky, the difference between which and the recent phenomenon being mainly that of the height of the substance reflecting the sun's rays.

It has never been ascertained what the substance is, and it may be that in different years it has not been the same. This might account for the appearance this year being less like cirrus than formerly. It has been suggested that it may be meteoric dust. T. W. BACKHOUSE.

Sunderland, August 11.

### August Meteors of 1908.

THE conditions this year were all against any bright or plentiful exhibition of the Perseids. Apart from the presence of the full moon, the sky at Bristol on August 11 and 12 was full of thin white clouds, amid which it was only possible to distinguish bright meteors. On August 10, however, the firmament was clear, but the Perseid shower was evidently influenced by the luminous atmosphere, for only about twelve per hour were visible before midnight. The radiant point was in the usual position at $43°+57°$. A few brilliant meteors were seen from Perseus on August 11, but clouds prevailed to such an extent that it was impossible to judge as to the strength of the display.

Mr. J. H. Elgie, of Leeds, had a clearer sky, and observed on August 10 and 11 a pretty numerous display of bright Perseids. Watching for an hour at about midnight on August 11, he saw twenty meteors. Reports from other places state that although some brilliant meteors were seen, they fell short in point of numbers with those observed in previous years in better circumstances. At Bristol the radiant point moved from $25°+53°$ on July 26 to $43°+57°$ on August 10. Watching was resumed early on the very clear nights of August 15 and 16, but meteors were found to be scarce, and the Perseid shower gave little sign of continued activity. W. F. DENNING.

## SOLAR VORTICES.

SOME preliminary investigations of Prof. Hale on the gyratory forms assumed by the hydrogen flocculi on the sun were described in a recent number of NATURE (vol. lxxviii., p. 200). The photography of the sun, through the hydrogen line Hα, using specially bathed red sensitive plates, by means of the 5-foot spectroheliograph of the Mount Wilson Observatory, gave promise of being of great value. Already the promise is kept. A copy of a paper which is to appear as No. 20 in a series of "Contributions from the Mount Wilson Solar Observatory" has been forwarded, together with illustrative photographs. After realising the advantage of the Hα line over the line Hδ previously used, the daily programme was modified to allow of a full series of photographs under the new conditions. A distortion due to heating of the mirror, now more continuously used, was eliminated by the use of a smaller aperture.

After obtaining new slits adapted to the Hα line, the first photograph of the entire solar disc by the modified method was obtained on March 28, 1908. The remarkable solar "vortex" previously reproduced in NATURE was secured by Mr. Ellerman, who was in charge of the routine work with the instrument, on April 30. Further information relative to this phenomenon appears in the more recent communication. On a less successful exposure made on April 29 the same large storm area is fairly well shown. A comparison with the afternoon photograph of April 30 recently made in the stereocomparator, together with the measurement of the latitude and longitude of objects identified on both dates, "seem to show the existence of a gyratory motion, in a direction opposite to that of the hands of a watch (north, east, south, west)." In Prof. Hale's first note on the same object, he remarks (NATURE, vol. lxxviii., p. 200) of the dark flocculi surrounding this area that "their appearances strongly suggest the effect of a great whirl rotating clockwise." The identification of objects on both plates is a matter of great difficulty, and the evidence for direction of rotation is admittedly weak. Further discussion of these plates is postponed until additional data become available.

The present communication from Prof. Hale is concerned chiefly with the phenomena recorded, by the aid of Hα, in the neighbourhood of a spot which reached the east limb of the sun at 8h. 16m. a.m. on May 26, 1908. The changes which took place about it in many cases rapid though not especially violent, were followed until June 2, when the attendant "whirl" was very marked. A long dark flocculus had persisted near the spot during this period. "On June 3, in an interval of about ten minutes, a remarkable transformation occurred. The long dark flocculus, which had been gradually changing in form and position, was suddenly drawn into the spot." The three photographs here reproduced illustrate this remarkable occurrence. They were taken on July 3 at 4h. 58m. 16s., 5h. 13m. 54s., and 5h. 22m. p.m. respectively. The times given refer to the transit of the spots across the primary slit of the spectroheliograph, while the scale is such that the sun's diameter would be represented by 14 inches. The definite incurving of the eastern end of the flocculus almost precludes the idea that it is a casual change at a level remote from that of the spots. Spectroscopic evidence of the motion of the flocculus *down* into the spot, during the period, would have been of interest. The records were obtained by Dr. C. E. St. John with the 5-foot spectroheliograph during Mr. Ellerman's absence on vacation. When the whirl was best seen its radius was about equal to the distance of the western extremity of the flocculus. Apparently the eastern end did not fall definitely under the influence of the whirl until its distance was about 140,000 km. from the spot. The fact that the western extremity lay, during the whole period, outside this magic radius may account for its escape. The mean of six

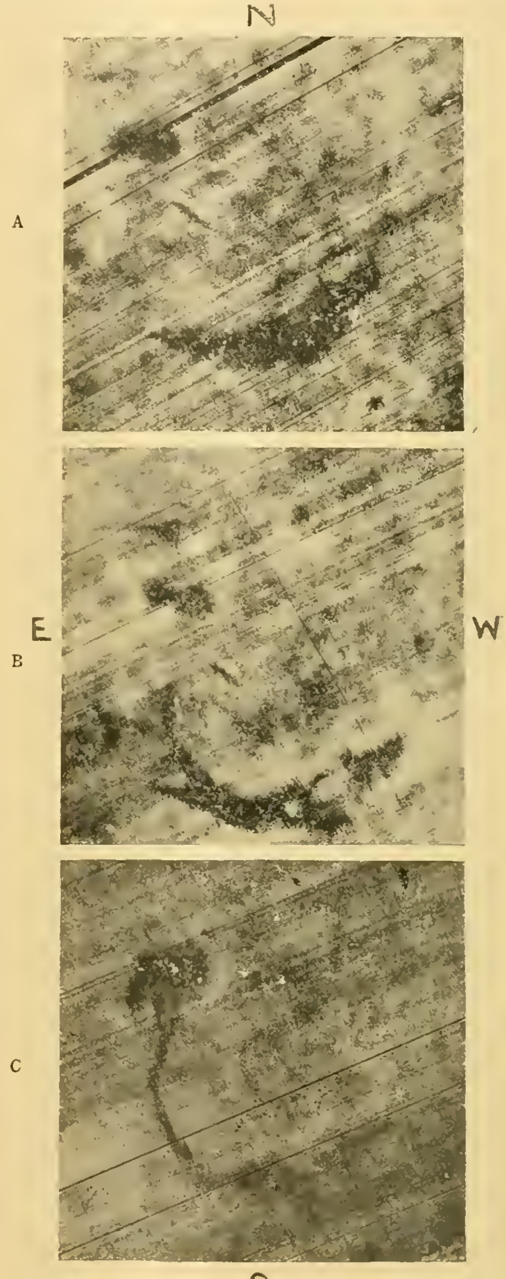


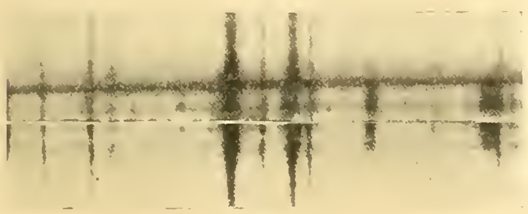

FIG. 1.—A hydrogen flocculus drawn into a solar whirl.
A at 4h. 58m. 16s. p.m.; B at 5h. 13m. 54s. p.m.; C at 5h. 22m. p.m.

measures of the velocity of approach of the flocculus gives 106 km. per second, which, it is suggested, is the order of the maximum velocity in the vortex. It is stated that, except in the case of the large flocculus, motion towards the spots, even along apparent lines of flow, has not made itself obvious.

Many visual observations of the drawing of photospheric matter into spots have been made, among others by Sir Norman Lockyer more than forty years ago, who described the apparent drawing of a willow leaf into a dark spot,[1] and the late Father Secchi, who was convinced that a swirl and a kind of suction existed in them.

A notable feature of a photograph taken after this indrawing, on June 5, is the amount of "bright eruptive hydrogen in the region surrounding the two spots." These opposite phenomena together strongly suggest Sir Norman Lockyer's sun-spot theory of a cooler central downrush with the later encircling *splash* of dissociated matter.[2] A gyratory motion in spots has been suggested by many observers. A number of problems as to the levels at which the activities recorded take place are suggested by the photographs. The remarkable fact of the non-participation of the high-level hydrogen in the differential rotation with latitude would at once follow if the equatorial acceleration were due to a fall of material from greater equatorial heights in the solar atmosphere. If the hydrogen is ascending in consequence of dissociation from the denser materials of the fall, it cannot show the same forward velocity as the falling material, to which velocity Lockyer ascribes the more rapid equatorial movement of the photosphere.[3]

The known correlation of the meridian passage of large spots or disturbed areas and the sudden changes in the magnetic elements has given currency to theories of the magnetic nature of this spot influence.



6302·71

Fig. 2.—Widening of spot line due to Zeeman effect.

A direct magnetic effect was negatived by Lord Kelvin on account of the excessive amount of energy required. A causal relation of this nature, whatever the intermediate step or steps, has been almost undoubted.

It is suggested by Prof. Hale that a segregation of positively or negatively charged particles caught into the stream of a solar vortex would give rise to magnetic lines of force at right angles to the plane of the swirl.

If such a field of force existed in a spot, the analogy of terrestrial experiment would suggest that the period of vibration of the ions emitting light in such a field should suffer modification. The light emitted from a spot near the sun's centre would be along these lines of force. The doubling of spectrum lines with the components circularly, and oppositely, polarised would be expected. Prof. Hale promised to make spectroscopic search for this Zeeman effect on the first opportunity. In a more recent letter he announces the complete success of his search.

Spectra of the light of a spot and of the photosphere were taken with the tower telescope and 30-foot spectrograph, having a Fresnel rhomb and Nicol prism mounted in front of the slit. The Zeeman doublets in the spot spectrum photographed under these conditions should change in relative intensity as the Nicol is rotated. When the spot was near the limb of the sun the results were uncertain, but when about 45° from the centre the characteristic changes were observed. The accompanying figure shows a pair of photographs in the region of the iron line λ 6302·71 taken on June 27. They are enlargements, the resulting scale being 1 Angström = 9 mm. The widening in the central spot bands of the line marked represents a true doubling. In the reproduction it will probably only be seen with difficulty that the relative intensities of the components are reversed in the two photographs due to the turning of the Nicol through 45°.

The separation of the components ranges from 0·018 to 0·216 Angströms. In several cases a tripling of lines was observed.

Every care was taken, of course, that the variations were not instrumental. Similar effects were found with other lines, though a remarkable and unexplained paucity of them occurred in the blue and violet regions. Further details are promised in a forthcoming paper of these exceedingly interesting discoveries.

The systematic recording of the solar magnetic fields for comparison with simultaneous records of terrestrial magnetism is suggested as desirable.

The ease, apparently, with which these varied records of solar activity can be obtained gives hope that soon will exist ample material for the discussion, and it is to be hoped the solution, of many of the outstanding solar problems.

From the perfect equipment at Mount Wilson much is expected, but no one will think of minimising the great credit due to Prof. Hale for the progress towards more intimate knowledge of the stupendous activities in the neighbourhood of the sun.

T. F. C.

## SOLAR MAGNETIC FIELDS AND SPECTRUM ANALYSIS.

Prof. George E. Hale, of Mount Wilson Solar Observatory, with great kindness has sent me a letter of date July 6, together with a copy of a manuscript destined for publication in Nature, on "Solar Vortices and the Zeeman Effect." Prof. Hale's paper is accompanied by two photographs on glass of the double lines in the spot spectrum between two comparison spectra of penumbra and photosphere of the region λ 6250–λ 6360. The position of the Nicol in the arrangement used was changed 45° between the first and the second of these photographs.

Prof. Hale asks me to examine the photographs of spectra, and to send a note to Nature expressing my opinion as to the interpretation of the results. I can say at once that I have come to the conclusion that Prof. Hale has given what appears to be decisive evidence that sun-spots are strong magnetic fields, the direction of these fields being mainly perpendicular to the sun's surface. Light received from a spot at the centre of the sun would in this case be parallel to the lines of force.

A source of light in the laboratory, and placed in a uniform magnetic field, emits, in the most simple case covered by the elementary Lorentz theory, parallel to the lines of force, two rays circularly polarised in opposite directions. Each spectral line is split up into a doublet of two circularly polarised lines, the one polarised clockwise, the other anti-clockwise. We may imagine that for further analysis a Fresnel rhomb and Nicol are mounted before the slit of the spectroscope, the arrangement actually used by Dr. Hale. The two circular vibrations of the doublet are

[1] *Monthly Notices*, vol. xxv., June, 1865, p. 236.
[2] "The Chemistry of the Sun," p. 412. (Macmillan and Co., 1887.)
[3] *Ibid.*, pp. 422 and 424.

transformed by the Fresnel rhomb in two normal and linear vibrations. It depends upon the position of the Nicol which of the components of the doublet is the more quenched.

The initial position of the Nicol determines the angle through which it is to be turned in order to reverse the relative intensities of the two components. Only widened lines and no doublets, and correspondingly only a shift and no extinguishing of components by turning the Nicol, will be observed, either from want of uniformity of the field or from want of homogeneity of the light.

The phenomena observed by Prof. Hale in the double lines and the widened lines of the sun-spot spectrum, and exemplified in the photographs under review, are identical in character with those observed in the laboratory under the specified conditions with somewhat broad lines or in a rather non-uniform field. The behaviour of a spectral line emitted in these circumstances by iron vapour between the poles of an electromagnet cannot be distinguished from the radiation of iron vapour immersed in the interior of a Hale (electronic or corpuscular) solar vortex at a distance of 149 million kilometres.

So far as we know, only a strong magnetic field can resolve a single line into a doublet, having components circularly polarised in opposite directions. Are we not compelled, then, to admit that where these unique and characteristic phenomena are present a magnetic field must be their cause? The evidence is of the same nature (but still more convincing by the unique character of the polarisations) as that for motion in the line of sight from the Doppler displacement of spectral lines in the case of moving stars or molecules.

The absence of any shift of the red telluric lines by the rotation of the Nicol, or of measurable displacements of the cyanogen flutings, as reported by Prof. Hale, considerably strengthens the argument and excludes instrumental and other errors.

A quantitative comparison of the magnetic separations of the iron lines as observed in the laboratory and in the sun will be necessary to complete the argument and to make it, if full correspondence exists, almost insuperable. A small probability, of course, must be left open that under the conditions existing in the solar furnace, dissociation processes or something of the kind (Lockyer) occur, so as to alter the whole vibrating system of the atoms and therefore also the relative separations of the different lines.

Being in the country I unfortunately cannot supply now the magnetic separations of the region of Prof. Hale's photograph.

The iron spectrum in the magnetic field has been examined by Becquerel and Deslandres, Reese, Kent, and Hartmann (Thesis, Halle, 1907), but the lines investigated are not far enough in the red.

Recently Miss van Meurs made in the Amsterdam laboratory a rather extensive study of the radiation of iron in the magnetic field, which will be published shortly; her observations in the red are still unfinished.

In order to obtain an idea of the order of magnitude of the magnetic force within the Hale solar vortex, we can only compare the largest separation of an iron line observed by Prof. Hale, viz. 0·22 A.U., with that of one of the larger separations of iron lines measured in the laboratory. The separation of $\lambda$ 4144·05 is 0·67 A.U. in a field of 29,740 Gauss. This gives for the magnetic force nearly 10,000, which may be reduced to, say, 6000 Gauss, if Dr. Hale's line presents such exceptionally high separation as some zinc lines.

If we might identify the Hale vortex with a solenoid with axis parallel to that of the vortex, and having one layer of one winding per cm., a current of 5000 amp. would be necessary for generating the 6000 Gauss field.

This current at first sight seems rather large. The actual case is approached more nearly by substituting for the one winding per cm. a gaseous conducting circular disc, one cm. thick, and of suitable radius, though all calculations here are merely tentative and extremely rough. Let the radius of this disc be chosen equal to that of the earth, viz. $6·4 \times 10^8$ cm. (representing a solar vortex of, according to Hale's photographs of the solar vortices, extremely moderate dimensions), then the current of 5000 amp. in the disc is to be distributed over an area of $6·4 \times 10^8$ cm$^2$., giving $0·8 \times 10^{-5}$ amp. per cm$^2$.

The kathode rays issuing from the spot of lime (say one square *milli*metre area) in a Wehnelt tube carry something like $10^{-5}$ amp. (I quote from memory). Hence the solar vortex would not be too crowded with electrons even if the magnetic force to be accounted for were much higher.

In the last paragraph of my very first paper (1897) concerning radiation in the magnetic field, I wrote:—"Further inquiry must also decide as to how far the strong magnetic forces existing, according to some, at the surface of the sun may change its spectrum." Since I always entertained the expectation, sometimes amounting almost to conviction, that some day a cosmical application of the magnetic separation of the spectral lines would be discovered by astronomers. This might suggest that I am too favourably disposed towards any evidence in such a direction.

I trust, however, that I have not been too sanguine while writing this review of Prof. Hale's splendid discovery. Its importance for general and solar physics must be very great, and not less for the theories of meteorology and terrestrial magnetism, affording, as it does, a *vera causa* for the perturbations of the electric and magnetic equilibrium of our earth and its atmosphere.

P. ZEEMAN.

## THE LIQUEFYING OF HELIUM.

ON July 10 Prof. H. Kamerlingh Onnes, of Leyden University, and his assistants had the satisfaction of seeing a considerable volume of liquid helium remain for some hours. This conquest over the last and most refractory gas was made known within a day or two, but few details were given until the appearance of the official publication, from which this note[1] is taken.

Prof. Onnes points out that the first step necessary was the determination of isothermals of helium, and in particular of those at temperatures obtainable only with liquid hydrogen. From these the *a* and *b* of van der Waals's theory can be obtained, and the Boyle point, *i.e.* the temperature at which the minimum of $pv$ occurs with very small densities, be found. This point also occurs at one-half the absolute temperature of the Joule-Thomson inversion point at low densities. With these data he was able to apply a theorem developed in 1896 from an earlier and more general theorem of 1881 during the endeavour to liquefy hydrogen statically. The theorem shows that the Boyle point of helium lies somewhat above the lowest temperatures obtainable with hydrogen, and hence that a regenerative process, as applied by Linde and Hampson to air and by Dewar to hydrogen, could be effective with helium.

Ever since 1883, when Prof. Onnes commenced his

[1] From the Special August Supplement to the Dutch Proceedings of the Royal Academy of Amsterdam. The note has been approved by Prof. Onnes.

work at Leyden, there has been continuous effort to reach the nadir of temperature. It has taken some years to get the necessary data for helium together. In 1905 much help was obtained from the Commercial Intelligence Office at Amsterdam under the direction of Mr. O. Kamerlingh Onnes, who obtained a sufficiency of the monazite sand, used for the preparation of helium, at a cheap rate. The helium is obtained from this by heat, and is then most carefully purified. The first isotherm determinations on helium were made in 1907. It was owing to Olszewski's and Dewar's failures that various methods, such as the helium motor with vacuum glasses as cylinder and piston, were considered, but these were abandoned, owing to the results of the isotherm determinations, which pointed to a critical temperature of about 5° to 6° K. This result was in better agreement with Dewar's estimate of 8° K. obtained from experiments of absorption by charcoal than with Olszewski's of below 2° K.

However, the conclusion from the isotherms was not quite decisive, as those at the lowest temperature indicated a lower critical temperature than those at higher temperatures, and this appeared to throw some doubt upon the strict applicability of the law of corresponding states to helium. At all events, just before the experiment was undertaken it was shown that the Boyle point, though below the boiling point of hydrogen, was somewhat above 15° K., which is obtainable with liquid hydrogen under reduced pressure.

The time had hence arrived to reap the fruit of the many years of work devoted to building up the cryogenic laboratory for the use of prolonged accurate measurements in liquid gases, with all the circulations so arranged that the gases remain pure. This is particularly important in the hydrogen cycle, where 4 litres of liquid can be dealt with per hour and a supply can be obtained in a state of great purity and stored for use.

In the arrangement of the experiment constant use was made of the theory of van der Waals. The apparatus was made as small as possible, but there was a practical limit which was fixed by its necessary relation to the other apparatus in use. To compress the helium the special mercury pump was used which was completed in 1888, and was used to give baths of static oxygen in 1894. It compresses to 100 atmospheres, which, with the critical pressure below 5 atmospheres for helium, is a high reduced pressure. This pump circulates 1400 litres per hour, which is sufficient with the dimensions of the apparatus taken, and has a capacity with connections of about 200 litres. For this experiment it was not possible to run the helium and hydrogen cycles at the same time, so that sufficient liquid hydrogen had to be made before the experiment on helium was commenced. However, now that the main difficulties are overcome, it will be possible to work the two cycles simultaneously.

In directing attention to Sir J. Dewar's work for this and similar researches Prof. Onnes points out especially the use he has made of the selective absorption of charcoal for gases in the purification of gases under pressure, and to the advantage of silvered vacuum glasses.

Such glasses are used at every stage of the work. For example, the liquid hydrogen is collected in an unsilvered glass placed in liquid air contained in a silvered glass with a strip of clear glass left to enable the interior to be seen. The liquid hydrogen is transferred by pressure through a fine tube into the experimental apparatus.

A detailed description is given in the paper of this apparatus, which is, however, simple enough in principle. The regenerator spiral, through which the compressed helium is expanded, is contained in the upper part of a vacuum glass also containing lower down the upper bulb of a helium thermometer. The helium glass is contained in a second which is filled with liquid hydrogen and connected to the hydrogen circulation. This glass in turn is contained in another filled with liquid air, and this finally in one containing alcohol. All these glasses are unsilvered, so that a clear view is obtained of the central glass and its contents.

The day before the successful experiment, July 9, was devoted to the preparation of 75 litres of liquid air, and at 5.45 a.m. on July 10 the work was commenced to obtain the necessary liquid hydrogen. By 1.30 p.m. 20 litres were standing in the special vacuum glasses. Meanwhile the helium and hydrogen circulations were pumped free of air and washed through with their respective gases, and a start was made to cool the liquid-air glass. At 2.30 hydrogen cooled by liquid air was taken through the hydrogen glass, and by 3 p.m. the temperature was down to −180° C. At 4.20 the helium circulation was started, liquid hydrogen was introduced into its glass, and the pressure lowered until at 5.20 p.m. it reached 6 cm., at which it was kept. Between 5.30 and 6.30 the pressure of helium in the spiral was gradually raised to 100 atmospheres. At 6.35, when the pressure was allowed to fall rapidly to 40 atmospheres, the helium thermometer indicated a temperature below that of the liquid hydrogen; nearly 6° K. was read once. At this time the last reserve of liquid hydrogen was connected, and no liquid helium had been seen. A quicker expansion was allowed, and the temperature fell and constantly returned to the same temperature of less than 5° K. It was as though the thermometer stood in liquid.

Somewhat later, at about 7.30, the surface was seen at the top of the vacuum glass. The liquid having been found under ordinary pressure there was no doubt that the critical pressure was more than 1 atmosphere. The surface was illuminated from below, and had the appearance of a liquid near the critical state in a Cagniard de la Tour tube, cutting the walls like knife-edges, though in this case the diameter was 5 cm. There was also a marked contrast between the helium and the hydrogen in the next outer tube. Some of the evaporated helium was now collected and used for a density determination giving 2·01. At 8.30 the pressure on the helium was reduced, and 2·3 cm. was measured. The pumps, however, can give 2 mm., and it is quite possible that as little as 7 mm. was reached, but no solid could be seen. At 9.40 only a few c.c. of liquid helium remained. Thus liquid helium, starting with an amount exceeding 60 c.c., had been under observation for more than two hours.

All the evaporated helium was collected into three portions, which gave densities of 2·04, 1·99, and 2·02. As a further test of purity a special comparative spectroscopic investigation was made with known mixtures of hydrogen with helium, and it proved that not more than 0·008 per cent. hydrogen was present. This high degree of purity is also confirmed by the easy working of all cocks, which would have been stopped by a very little frozen hydrogen, and also by the condition of the last remaining liquid. The thermometer was also controlled by a measurement of the boiling point of oxygen, which gave 89° K. instead of 90° K.

The properties found are as follows:—A boiling point of 4°·3 K. on a constant volume helium thermometer with a pressure of 1 atmosphere at about 20° K. Corrected to the absolute scale the best value would appear to be 4·5° K. The triple point, if it exists, is certainly below 1 cm., perhaps below 7 mm., at which, by corresponding states, the temperature would be about 3° K., and the liquid remains very mobile.

Liquid helium has a density of 0·15, which gives $b$ a value of 0·00017, about twice that which has been assumed before from then known properties and used in calculations. From this, again, the critical pressure must be about 2 to 3 atmospheres, so that helium under 5000 would correspond with carbon dioxide under 100,000 atmospheres. At the boiling point the ratio of vapour to liquid density is 1 : 11, which indicates a critical temperature of not much more than 5° K., and a critical pressure of about 2·3 atmospheres. Lastly, the value of $a$ will be about 0·00005, the smallest value known, but a most interesting confirmation of van der Waals's contention in 1873, that there must be some attraction between the molecules of all substances.

FRANCIS HYNDMAN.

## THE ETIOLOGY OF TRYPANOSOMIASIS.

IN a communication to the Paris Academy of Sciences on February 24, some remarkable discoveries concerning the development of pathogenic trypanosomes in tsetse-flies are brought forward by M. E. Roubaud, member of the Mission Française d'Études de la Maladie du Sommeil. Experimenting with four species of pathogenic trypanosomes, namely, *Trypanosoma gambiense*, *T. dimorphon*, *T. brucei*, and *T. cazalboui*, and with *Glossina palpalis*, Roubaud found that immediately after the fly has fed on the blood of an infected animal, its proboscis contains blood in which the trypanosomes are moving actively. In a very short time, however, the trypanosomes attach themselves to the wall of the proboscis and undergo changes of structure, becoming Herpetomonas-like, with the kinetonucleus in front of the trophonucleus. The undulating membrane has disappeared, and the flagellum, as the organ of fixation, is greatly thickened, so as to resemble a small stalk to the body. These changes are complete in five minutes after ingestion of the blood. The attached parasites at first exhibit active movements of the body, but soon become quiescent; no phenomena of conjugation could be observed, either before or after these changes. But the parasites multiply actively in this situation, forming little tufts or colonies, so that at the end of one hour they have become excessively numerous; they are found attached to the internal face of the labrum, sometimes chiefly at the base of the proboscis, in other cases along its whole length as far as the point. When observed in the salivary fluid they appear immobile, but when treated with serum or with physiological salt-solution they vibrate rapidly and may become free, in which case they swim with the flagellum forward and the hinder part of the body rigid, thus differing greatly in appearance from the original trypanosome-form. The free parasites have a great power of attachment, and when under observation they may fix themselves firmly to the slide.

The author regards this development as a temporary culture or "culture d'attente" of the parasites. Both by observation and experiment he shows that the forms in the proboscis are not derived from trypanosomes regurgitated from the digestive tract of the tsetse. *T. brucei* was found to die out without multiplication in the intestine of *Glossina palpalis* in a short time. The culture in the proboscis was found to persist beyond forty-eight hours in the case of *T. brucei*, and for five or six days in the case of the other three species of trypanosomes. Only about ten per cent., however, of the tsetses fed on infected animals developed a culture of the trypanosomes in the proboscis. On the other hand, the power of multiplying in the proboscis was found to be a specific relation between the trypanosomes and the tsetse.

These observations lack as yet the crucial test of an experimental infection by means of the proboscis-culture, but nevertheless they throw great light on the problem of the transmission of pathogenic trypanosomes. It has been shown by previous experimenters that the transmission is effected by the direct or mechanical method, and all attempts to prove experimentally an indirect or cyclical mode of transmission have given negative results. That being so, it was difficult to understand why the power of direct transmission should be possessed, apparently, by tsetse-flies alone, and not by other biting insects to an equal degree. Roubaud's observations show that the pathogenic trypanosomes have a quite specific power of adapting themselves to the salivary secretions of the tsetse, and thus explain the peculiar relation between these flies and the spread of diseases caused by trypanosomes in Africa. Moreover, a very important new line of investigation is indicated by the author's discoveries.

E. A. M.

## NOTES.

ABOUT a year ago Sir William Ramsay and Mr. A. T. Cameron announced that they had observed the production of the alkaline metals and lithium in solutions of copper salts submitted to the action of the radium emanation, and concluded that in the presence of the emanation copper underwent a degradation into the elements potassium, sodium, and lithium. In the current number of the *Comptes rendus* of the Paris Academy of Sciences, Mme. Curie and Mlle. Gleditsch give an account of the attempts they have made to repeat this experiment. They first point out the extreme difficulty of obtaining chemical products free from lithium. This metal was found in distilled water and in nearly all the reagents. If a reagent, free from lithium, is allowed to stand in a glass vessel, traces of this metal are found after some time. Even fused quartz is not a safe material, since both opaque and transparent quartz were found to contain notable amounts, the latter furnishing the larger proportion. The experiments had therefore to be carried out in such a manner that the solutions came in contact with platinum only; the water and the acids necessary for the experiment were re-distilled from platinum and preserved in platinum bottles, and after this treatment no lithium could be detected in the residue from 25 c.c. of the nitric acid, 25 c.c. of hydrofluoric acid, and 250 c.c. of water. The quantities of copper and radium emanation were about the same as those used in the original experiment. The salt residues obtained weighed 0·4 and 0·5 milligram, the control experiments giving 0·3 and 0·2 milligram. Spectroscopic examination of this residue showed it to consist of salts of sodium with a little potassium; the presence of lithium could not be proved. Direct experiments on known mixtures of sodium and lithium sulphates showed that the amount of lithium present in the residue, if any, must be less than $0{\cdot}6 \times 10^{-5}$ milligrams. In conclusion, the authors state that they have been unable to confirm the experiments of Messrs. Ramsay and Cameron. It is impossible to state that no trace of sodium or lithium is formed in this experiment, but they consider that the fact of the formation of these elements cannot be considered as established.

For the second time during the present summer a drought has occurred over England, and the present occurrence is of considerable duration. At Portland Bill absolutely no rain fell from July 17 until Tuesday, August 18—a period of thirty-two days—and at Jersey the aggregate measurement of rain for the period was only 0·07 inch. In London the total measurement of rain for thirty-one days is 0·22 inch, which fell on three days. Rain has fallen rather more frequently in Scotland and Ireland, but in these parts of the kingdom the shortage of rain is considerable. At Leith the measurement for twenty-four days is 0·11 inch, whilst at Roches Point it is only 0·08 inch for twenty-three days, and even at Valencia the aggregate measurement of rain this month is 0·11 inch. The Weather Summary issued by the Meteorological Office shows a considerable deficiency of rain for the present summer. In the extreme south of England, the English Channel stations show a deficiency of 3·26 inches, whilst for the south-west district of England the deficiency is 3·07 inches, and in the south of Ireland 3·01 inches. In most districts the aggregate rainfall since the commencement of the year is less than the average, the deficiency amounting to 5·7 inches in the English Channel, and exceeding 4 inches in the south-west of England and in the south of Ireland.

The International Historical Congress has accepted the invitation of the British Academy to meet in London in 1913.

Dr. H. Morize has been appointed director of l'Observatoire de Rio de Janeiro in succession to the late Prof. L. Cruls.

Referring to the subject of the standardisation of time, a correspondent points out that in Antwerp there is a system by which, at various prominent points of the city, clocks are shown "connected electrically with the observatory."

Some interesting experiments on coal-dust explosions have been started, under the direction of Mr. W. E. Garforth, at the Altofts Colliery, Yorkshire. An experimental explosion was witnessed on August 14 by Mr. E. Reumaux (Lens), Dr. J. A. Holmes (United States Geological Survey), Captain Desborough, H.M. Inspector of Explosives, and a number of experts from France and the United States. The cost of the experiments is borne from a special fund of 10,000*l.* contributed by colliery proprietors.

We regret to see the announcement that Prof. F. Paulsen, professor of moral philosophy in the University of Berlin, died on August 14, at sixty-two years of age. Prof. Paulsen was the author of several important volumes on philosophy and ethics, and he wrote extensively on educational subjects, among these works being "Die deutschen Universitäten," "Geschichte des gelehrten Unterrichts auf den deutschen Schulen und Universitaten," and a volume on past and present German education, of which a translation into English has been published recently.

We regret to see the announcement of the death, at the age of sixty-two, of Prof. Alfred Giard, professor of general biology at the Sorbonne, Paris, and member of the Paris Academy of Sciences. He was a student at the Superior Norman College in 1867, and became a Doctor of Science in 1872. In the following year he became professor of natural history at the Industrial Institute of the North of France, in 1880 professor of zoology in the University of Lille, founder of the marine biological laboratory at Wimereux in 1884, and professor at the Sorbonne in 1887. His researches and lectures on general embryology and the evolution of living forms gave him a high position among biologists. Prof. Giard was elected vice-president of the Société de Biologie in 1896, and president of the Société entomologique in the same year. In 1900 he became a member of the Paris Academy of Sciences in succession to Prof. Milne-Edwards.

Dr. Charles Taylor, the master of St. John's College, Cambridge, who died suddenly at Nuremberg last week, was a man of varied and sound learning, which has secured for him a permanent place in mathematical as well as in theological literature. His larger book on geometrical conics is remarkable for its elegance, its well-arranged historical notes and prolegomena, and its treasury of examples. The smaller treatise does not suit every kind of student, especially for examination purposes, but it has enjoyed considerable popularity, and is, in many respects, one of the most attractive and enjoyable works on the subject. While thoroughly at home in the methods of the ancients, Dr. Taylor never fully absorbed the projective theory of the moderns; for example, his notes on the circular points at infinity are merely ingenious trifles, and obscure, rather than elucidate, the geometrical meaning of these ideal elements. Apart from this, he rendered a real service to mathematics by devoting so much time to a limited subject with which he was specially competent to deal, and his *magnum opus* in this field is not likely to be superseded.

The measures devised by Sir Henry Hesketh Bell, Governor and Commander-in-Chief of Uganda, for combating the spread of sleeping sickness are, according to Reuter's Agency, meeting with a considerable measure of success. During 1907 there were no new cases among Europeans, and the deaths among natives during the twelve months numbered less than 4000. The whole of the population has been removed from the shores of the Victoria Nyanza, and it is hoped that the disease-carrying fly in that belt, if not re-infected, will gradually cease to be a source of danger. Several thousands of the sufferers from sleeping sickness are being maintained in segregation camps, but the treatment by atoxyl is not proving of much avail. Consistent and vigorous action will be necessary for some years to come if sleeping sickness is to be stamped out of the country.

We learn from the *British Medical Journal* that, on October 15, the University of Bern will initiate a great festival in celebration of the two hundredth anniversary of the birth of the great physiologist, botanist, and poet, Albrecht von Haller. Prof. Steck will deliver an address on the personal characteristics of Haller, Prof. Kronecker will discourse of Haller's Bernese home and of his method of working, and Prof. Fischer will treat of Haller's relations with the scientific men of his time, and especially of his relations with Linnæus. On October 16 a monument to Haller's memory will be unveiled on the ground facing the new university buildings. Haller was elected a Fellow of the Royal Society of London on October 25, 1739, when he was only thirty-one years of age; and Prof. Arthur Gamgee, F.R.S., will present, in the name of the society, a Latin address to the University of Bern.

Reports as to progress of experiments in wireless telephony appeared in the daily papers during the past few days. The Paris correspondent of the *Times* states that experiments made at the Champ de Mars have established communication with Mont Valérien at a distance of 8 kilometres, Villeneuve St. Georges at 20 kilometres, and Mélun at 50 kilometres. The *Daily Chronicle* correspondent at Milan states that Prof. Majorana is engaged in installing his system of wireless telephony between Rome and Sardinia, after a successful series of experiments between Montemario, the military fortress in Rome, and the Porto d'Anzio Lighthouse, during which communications were distinctly heard over the intervening distance of thirty-six miles. The Central News Agency reports that three French naval officers have succeeded in constructing an apparatus by which they claim to be able to hear singing and speaking distinctly between Paris and Dieppe, a distance of 100 miles. This is announced as a remarkable achievement, but we learn from the *Electrician* that effective wireless telephonic communication was established some time ago between Syngby, near Copenhagen, and Weissensee, near Berlin, a distance of 260 miles.

In the *Times* of August 15 Dr. R. Munro records the discovery of a second lake-village in the neighbourhood of Glastonbury, where excavations have been in progress since 1892 under the supervision of Mr. A. Bulleid. The village recently discovered is situated at Meare, about two miles north-west of Glastonbury. It is clear that the area occupied by these villages was originally a sheet of water, the overflow from which found its way into the Bristol Channel fourteen miles distant. The objects hitherto discovered at Meare consist of long-handled weaving combs, clay sling-bullets, and a few articles of bronze, including a curious finger-ring, with bones and teeth of domestic animals. The manufactured specimens belong to what has been termed the "late Celtic" period, of which sporadic "finds" have occurred in various parts of the country; but Glastonbury is the first inhabited site which has furnished evidence of the entire social life of a late Celtic community. Dr. Munro appeals for funds and the assistance of archæologists in the excavation of this interesting site.

Prof. Milne reports to the *Daily Mail* the occurrence of a seismic storm at the end of last week. On August 13 he recorded three earthquakes at Shide; and on August 14 there was a fourth, which commenced at 1.8 a.m. and attained its maximum twenty-six minutes later. The records indicated that the origin of the disturbance was at a distance of 3800 miles. A message from Prof. Michie Smith to the *Daily Mail* states that at the Kodaikanal Observatory on August 17 an earthquake was recorded commencing at 11.3 a.m. (Greenwich Time). The long waves began at 11.35 a.m., and the maximum was reached at 11.38. At 6 a.m. on August 18 a violent earthquake occurred at Terni, in the province of Perugia. Very strong shocks were also felt at Messina, in Sicily, and the surrounding country. It is also reported that fissures half a mile in length were caused by an earthquake which occurred at the town of Eureka, California, on the morning of August 18.

The French expedition to Antarctic regions, under the command of Dr. François Charcot, left Havre on August 15 in the *Pourquoi Pas*. The French Parliament made a grant of 32,000*l*. for the expedition, and the Prince of Monaco, the Paris Geographical Society, and other scientific bodies have assisted in its organisation and equipment. From the Paris correspondent of the *Times* we learn that Dr. Charcot expects to be absent about two years. One of his objects in returning to the regions of the South Pole is to bring back specimens of the fossils to which Dr. Nordenskjöld has already directed attention. He intends to transport them to one of the open ports of the Antarctic continent, either Port Lockroy or Port Charcot, and then to go on to Loubet Land to begin his exploration of the regions to the south. He has taken with him provisions for twenty persons for more than two years. The *Pourquoi Pas* is expected to arrive face to face with the southern ice about December 15, at about 800 kilometres south of Cape Horn. Dr. Charcot's staff includes M. Bougrain, who will make the astronomical observations; M. Rouch, specialist in meteorology and oceanography; M. Godefroy, who will study the hydrography of the coast and the tides; M. Gourdon, geologist; and Dr. Jacques Liouville, marine zoologist and botanist. Six automobile sleds will, it is hoped, enable the expedition to make its way well into the interior along the glaciers, and supplement the services rendered by the skis. The *Pourquoi Pas* is 41 metres long, 9.20 broad, and has a tonnage of 800.

The surviving members of the Denmark Greenland Expedition arrived at Bergen on August 15, and Lieut. Trolle, master of the *Denmark*, the vessel of the expedition, has given further particulars of the lamentable death of the leader and his two companions. It appears from a Reuter message that a harbour for the ship was found in latitude 76¾°. Mr. Erichsen, Lieut. Hagen, and Mr. Brönlund perished in November, 1907, in an attempt to return from the north coast of Greenland over the inland ice, having been obliged to remain on the north coast through the summer, owing to the state of the weather. A sledge expedition was organised in the spring of 1907, under the command of Mylius Erichsen, to explore the unknown part of the north-east coast of Greenland. The expedition consisted of ten sledges in four batches. Three of these returned before the beginning of summer, and in September, 1907, an expedition was sent out to find the fourth party, which had not returned. At 80° the expedition found open sea close to the coast. In the course of the autumn numerous sledge expeditions started, and in March, 1908, a fresh rescue party set out, which brought back definite news of the fate of the missing sledge party. During the spring several other sledge journeys were made on the inland ice towards the south, as far as Ardencaple. The coast of Greenland was explored as far as Cape Bridgman, 83½°, and into Peary Channel to Cape Glacier. The coast line took a much more easterly direction than was expected, and connection was made with Peary's landmark on Peary Land. At Cape Glacier the Danish flag was hoisted, and the country taken possession of for Denmark, and called King Frederic VIII. Land. No living people were encountered. Scientific expeditions were continuously made into the district surrounding Port Denmark, and also from the ship. On the road large collections were made, and a mass of scientific material was collected; numerous sketches, paintings, and photographs of the country were also made.

A little pamphlet entitled "Die neuere Tierpsychologie," by Dr. Otto Zur Strassen, has been received from Mr. B. G. Teubner, of Leipzig and Berlin. The essay, though general in form, contains numerous references to experimental results. The author cannot, however, be considered to have proved the conclusion which he eventually reaches, viz. that a physicochemical explanation of animal behaviour is possible and sufficient from the protozoa to the primates.

In a paper on the variations and genetic relationships of the American garter-snakes, forming Bulletin No. 61 of the U.S. National Museum, Mr. A. C. Ruthven expresses the opinion that the work of systematic naturalists should be more specially directed towards throwing further light on the problems involved in the origin of species. The barrenness of general results in this direction, particularly in work on reptiles, cannot be entirely attributed to lack of facts, but, in some degree at any rate, is due to the methods employed. Garter-snakes follow the usual laws of geographical distribution, closely related forms on the same line of descent generally inhabiting adjacent regions. Originating apparently in northern Mexico, the garter-snakes became there differentiated into four main groups, which subsequently radiated in all directions, but principally to the northward. Wherever they entered different regions, the different environmental conditions acted unfavourably, retarding growth, and differentiating the group into dwarfed forms.

IN a paper on the ancestry of the tailed amphibians, published in the June number of the *American Naturalist*, Dr. R. L. Movelić comes to the conclusion that the labyrinthodonts or stegocephalians should be split up into two distinct groups, namely, the Branchiosauria of the Carboniferous and Permian, on the one hand, and a second group, embracing the Microsauria, Aistopoda, and the more typical labyrinthodonts, on the other. The first group is regarded by the author as representing the ancestral stock of the modern tailed amphibians, whereas the second is closely related to reptiles, and should not improbably, indeed, be included in that class. From the Microsauria, in which the ribs are long and curved, the Branchiosauria, as typified by the minute Protriton (Brachiosaurus) of the European Permian, are distinguished by their short ribs, which articulate with the transverse processes of the vertebræ. The Branchiosauria agree, in fact, with the modern Amphibia Caudata in their short, straight ribs, the stout transverse processes arising from the bodies of the vertebræ, practically in the number of the presacral vertebræ, as well as in the structure of the skull and pectoral and pelvic girdles, in the number of the toes (four in front and five behind) and of their component segments. as well as in the structure of the long bones, the shape of the body, and the existence of a lateral-line-system. In skull-characters, as well as in the shoulder-girdle, the modern tailed amphibians exhibit marked signs of degeneration, and they may accordingly be regarded as degenerate derivatives of the Branchiosauria. Similarly, the Aistopoda are provisionally regarded by the author as a degenerate branch of the Microsauria.

THE Uganda Protectorate comprises numerous districts, such as Busoga, Bukedi, Unyoro, Toro, Ankole, &c., and the kingdom of Uganda. In the "Official Gazette of the Uganda Protectorate," vol. i., No. 6 (June 15), the following notice appears:—"The Secretary of State for the Colonies has approved of the use officially of the name Buganda for the Kingdom of Buganda, as distinct from the word Uganda, which is still to be used as designating the whole of the territory included within the Protectorate." As an example of the great strides that civilisation is making in Central Africa, it may be noted that in the same "Gazette" tariffs are quoted for motor-waggon and motor-car fares between Entebbe and Kampala.

A GREAT deal has been written about the antiquity of the use of iron in China. Commandant Bonifacy (*Bull. Soc. d'Anth.*, Paris, 1907, p. 512), from a study of the languages of numerous tribes in south China, finds that since a long period of time the metals have borne sometimes a Chinese name and sometimes a particular name which varies according to the tribe, from which he naturally concludes that certain of these metals were introduced by the Chinese, whereas others were known to the tribe before its contact with Chinese civilisation; iron belongs to the latter group, and copper and bronze to the former. Hence the tribes of south China and of Indo-China knew iron before copper. They employed worked flint in China 2200 years B.C., when iron was already known. China has not passed through an age of bronze or copper.

IN the *Essex Times* of August 8, the Rev. J. W. Hayes, of West Thurrock Vicarage, Grays, has directed attention to some old underground workings for chalk at Hemel Hempstead, which in his opinion throw much light on the origin and use of dene-holes generally. It appears that in order to obtain chalk suitable for lime-making it was until recently the practice in parts of Hertfordshire to work the chalk in subterranean chambers reached by deep shafts. One pit, dug as lately as 1882, attained a depth of 90 feet. A vertical shaft, of circular section, about 5 feet in diameter, was sunk through superficial deposits until the hard chalk was reached, and from the bottom of the shaft three so-called "arches" were struck out. These arches were chambers, which in some cases were more than 12 feet high. The chalk was mined in these drifts for a length of twenty to twenty-five yards, and when the distance of the working face from the bottom of the shaft became inconveniently great, or when the roof proved unsound, a new pit would be sunk. The centre of the industry was the parish of Hemel Hempstead, but many abandoned pits are to be found in the country between Tring on the west and Shenley, near Barnet, in the south.

WE have received copies of a new publication, *Neue Weltanschauung*, published in Stuttgart under the editorship of Dr. W. Breitenbach, with the object of diffusing the results of modern scientific research in its application to philosophy and culture. The editor contributes an article on modern theories in connection with heredity and their scientific foundation, in which he discusses the "pangenesis" theory of Darwin, de Vries's theory of "pangenes," and Haeckel's conception of "plastidules." An appreciation of Charles Darwin, and a photographic reproduction after Collier's drawing, have been evoked by the Darwin jubilee.

A LIST of rare shrubs for growing in the open garden, compiled by the Hon. Vicary Gibbs, is published in the Journal of the Royal Horticultural Society (vol. xxxii., part ii.). The author prefaces the article with the intimation that his remarks refer to plants grown in Hertfordshire on a cold, clay soil where severe frosts are experienced in late spring. *Rosa ferruginea* among the roses, *Colletia cruciata*, *Cotoneaster acutifolia*, and *Sambucus canadensis* are some of the plants receiving special commendation; several species are selected under the genera Berberis, Spiræa, Ribes, Syringa, and Ilex. The author also mentions the tree pæonies, varieties of *Paeonia Moutan*, that he has imported directly from Japan. In the same number of the journal Mr. J. Hudson discusses the subject of plants for terrace gardening. He supplies useful notes on the methods of training scented geraniums, and recommends the species *radula major*, "Clorinda," and *capitatum*. *Aloysia citriodora* is another choice, and some bamboos, palms, and species of Phormium are suggested.

THE Philippine Weather Bureau has just issued part ii. of the annual report for 1905. Besides the Central Observatory at Manila, the Bureau controls forty-four secondary stations, seven being of the first order. The report contains the daily meteorological observations made at all these stations during 1905. At the first- and second-order stations the observations are made six times a day; at the third- and fourth-order stations twice a day. The data are collected into monthly batches, but although the monthly means are there, they are not brought together so as to form annual summaries for the various stations.

In a letter we have received from Mr. H. H. Scott, meteorological observer for Launceston, Tasmania, some interesting observations on the sinking of stones are recorded. In the course of the day Mr. Scott twice traverses in full daylight a piece of public land between two thermometer screens. Much of the surface of this land is charged with brick dust, and on it fragments of diabase have been scattered. In the absence of frost the path between the screen remains firm and compact. During June last twenty-one of the first twenty-nine days commenced with frost, and outside thermometers read as low as 19°·3 F. Later in the day bright sunshine followed, and the reading of the solar thermometer sometimes reached 101° F. Consequently, the ground was first frozen, then soaked with moisture, and afterwards warmed considerably. Mr. Scott noticed that day by day the earth round the fragments of diabase appeared to be lifting slowly. On June 29 he found some fragments to be 18 mm. to 20 mm. below the surrounding surface, and in the case of unusually large pieces of rock even deeper. No earthworms were at work in the neighbourhood of the stones, and the alteration in level appeared to be due wholly to atmospheric agency.

In the "Album der Natuur" Dr. J. G. van Deventer writes on the Warner Powrie method of colour photography, and refers to an article in NATURE, October 24, 1907 (vol. lxxvi., p. 642). In this method, coloured lines replace the coloured dots of the Lumière process, about 320 lines being the average to the centimetre. The advantages are that the colour screen is more regular with alternating colour-bands, and that positive prints can be made on paper. The colour screen is prepared from bichromatised gelatin by exposure under a screen of bands divided by spaces half their width. The resulting ridges of gelatin are stained with appropriate dyes, and then present a series of coloured bands of which the relative thicknesses are as 1, 2, and 3 for the colours violet, green, and orange, the absolute thickness varying from 5 to 40 microns. Sensitive emulsion is then deposited over this screen, and a transparent positive obtained as with the Lumière method. To obtain further positives, use is made of the already known Uto paper. In this the sensitive layer is mixed with three organic dyes complementary to those in the screen, and mixed with anethol. This gives the property that the absorption of a colour causes the same coloured dye to become colourless. In this way a positive coloured print is obtained. Dr. Deventer does not think that ordinary Uto paper containing silver can be used. He shows how Powrie uses two mirrors at an angle of 110° with a thin glass plate between the positive plate and the paper, obtaining the combination empirically which results in giving the best intensification and elimination of any dark bands. The paper ends with a description of the method of obtaining the *clichés* for three-colour printing.

We have received new catalogues of electrical and other apparatus from Messrs. Siemens Bros. and Co. and from the Cambridge Scientific Instrument Co. which should prove useful to those who are considering the purchase of apparatus for the coming winter. The latter catalogue is in the form of a file, with an arrangement at the end to enable sheets issued in the future to be readily attached. It also gives more information about the sensitiveness of the various instruments described than we have seen previously in any instrument maker's catalogue.

The attempts which have been made in the past to substitute some instrument for the eye in accurate photometry have not been very successful owing to the methods adopted not having proved so sensitive as the eye. M. Charles Féry appears to have overcome this difficulty by an arrangement he described to the Société française de Physique in May, which is given in the August number of the *Journal de Physique*. The light to be tested is placed a metre away from a lens, which forms an image of the source on the receiving disc of a Boys radiomicrometer. Between the lens and disc the light passes through a layer of water 4 cm. thick, containing copper acetate of such strength that there is 1 gram of copper in a litre of solution. This solution, the author finds, cuts out of the beam those radiations which do not affect the eye, and the instrument gives results for different sources which are in close agreement with those given by the Lummer-Brodhun photometer. It also enables the optical efficiency of the source, *i.e.* the ratio of the luminous to the total radiation, to be readily found.

Prof. J. C. McLennan, University of Toronto, described in NATURE of May 14 (p. 29) some experiments which led him to conclude that the radio-activity of potassium and its salts is not connected with a *normal* atomic property of the metal. The salts used were those ordinarily sold by the best makers as chemically pure, and in arriving at the conclusion mentioned it was assumed that the salts used possessed, at least approximately, the high degree of purity claimed for them. Prof. McLennan now writes to say that analysis has proved this assumption to be incorrect. A comparison of the percentage by weight of potassium in several salts with the radio-activities of the salts has shown that the salts which contained the most potassium were those which exhibited the strongest activity, and that for the more active ones the radio-activity was almost directly proportional to the amount of potassium present.

Messrs. Crosby Lockwood and Son send us the first number of a quarterly circular of engineering and technical literature (classified under subjects) just published by them. The circular contains particulars of the most important works in engineering, science, and technology published during the past three months in England and in America, and as it will be repeated every quarter it should prove of assistance to engineers.

The nineteenth annual general meeting of the Institution of Mining Engineers will be held at Edinburgh on September 2–4. The following papers will be read, or taken as read:—coal-dust to date and its treatment with calcium chloride, H. Hall; on the practical use and value of colliery rescue-apparatus, G. Blake Walker; the Wemyss coal-field, J. Gemmell; the working of oil-shale at Pumpherston, W. Caldwell; deep diamond boring, J. Thomson.

In the Bulletin of the Johns Hopkins Hospital for July (xix., No. 208), Prof. Howard Kelly, in an article entitled "The Barred Road to Anatomy," gives an interesting account of the "body snatchers," Burke and others, and of the times in which they lived, from the point of view of the study of anatomy.

Messrs. Burroughs, Wellcome and Co. have issued an interesting and well-produced guide, with descriptive catalogue, of their exhibits at the Franco-British Exhibition; also pamphlets describing their laboratories, and the research work that has been carried out in them.

The *Philippine Journal of Science* for April (iii., No. 2) contains a number of important papers relating to medical science—on cholera, on typhus fever, on the virus of cattle plague, and on the venom of the "habu," a venomous snake found in some of the Japanese Islands.

In No. 33 of the Scientific Memoirs of the Government of India Colonel Bannerman discusses the production of alkali in broth culture media by the plague bacillus, which may reach an amount equivalent to 1·5 per cent. to 2·5 per cent. of normal sodium hydroxide.

## OUR ASTRONOMICAL COLUMN.

Another Large Sun-spot Group.—The renewal of the sun-spot activity illustrated in these columns last week is being well maintained. On Wednesday, August 12, the large groups shown on our photograph had reached the western limb of the sun's disc, and on Thursday bad weather prevented observations entirely at South Kensington; but on Friday morning it was seen that a large scattered group of small spots had broken out near the centre of the disc, whilst numerous small spots were scattered over the surface. This new group was visible to the naked eye, and has apparently evolved from a prominent group of faculæ which was observed near the eastern limb earlier in the week.

The Total Solar Eclipse of December 22–23.—Further particulars concerning the possibility of observing the total eclipse of the sun in the Antarctic, in December next, are contained in a letter we have received from Prof. Wilhelm Krebs.

Prof. Krebs points out that both Bouvet Island and the more northerly Thompson Island lie outside the real ice limits, and that only small, isolated icebergs were observed by the expedition ships that have recorded them. Thus, with a totality lasting, according to his calculations, 11·3 seconds, it might be possible to secure pictures of the corona at Bouvet, or Thompson, Island in December. Meteorological and magnetic observations could be carried out, as also could observations of the shadow bands and of the radiation variations. The approximate times of mid-eclipse in different longitudes are shown below:—

| Longitude ... | W. 60° | 40° | 20° | 0° | 20° | 40° | 60° E. |
|---|---|---|---|---|---|---|---|
| | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. |
| G.M.T. Dec. 22–23... | 22 15 | 22 37 | 23 11 | 23 45 | 0 15 | 0 43 | 1 6 |

One Hundred New Double Stars.—Prof. R. G. Aitken's twelfth list of double stars is published in No. 134 of the Lick Observatory Bulletins, and brings the total number now discovered up to 1800. All the double stars in this list were discovered and measured with the 36-inch refractor, and attention is directed to Nos. 1745, 1746, and 1777, which add closer companions to OΣ 190, Σ 1224, and Σ 1579 respectively.

The Night-glows at the Beginning of July.—In No. 4266 of the *Astronomische Nachrichten* (p. 297, August 1) Prof. Max Wolf discusses the night-glows which attracted so much attention about July 1. On that date Prof. Wolf was unable to carry out his usual programme of photography because the sky-glare was far too bright, and in the north only such stars as Capella and α and β Ursæ Majoris were easily visible to the naked eye. At first Prof. Wolf suspected that a display of aurora was taking place, but failure to observe the aurora spectrum or any fluctuations of the light led him to conclude that the phenomenon was due to the peculiar high cirrus cloud that prevailed.

The Employment of Selenium Cells in Photometry.—Readers of these columns will remember that some time ago Messrs. Stebbins and Brown, of the Illinois University Observatory, made photometric observations of the moon's light, using selenium cells (see Nature, January 16 and 30, pp. 258 and 302), and subsequently showed that the great differences found were due to the different colour-sensibilities of these cells (Nature, May 7, p. 18). Referring to these observations in No. 1, vol. xxviii., of the *Astrophysical Journal* (p. 83, July), Prof. Pfund points out that the curves determined by Mr. Stebbins are not true sensibility curves, because the energy curve of the spectrum employed was not taken into account. He also suggests that, at the present time, the use of selenium cells is unwarranted except in observations of the variations of a light source of which the effective area alone changes. A method of employing selenium cells in combination with colour screens for the determination of stellar magnitudes has been devised by Prof. Pfund, and will be fully discussed in a future publication.

Eclipses of Saturn's Satellites.—During the coming opposition of Saturn, Rhea and the inner satellites will be eclipsed. The following times of eclipse are taken from a paper published by Dr. H. Struve in No. 120 of the Publications of the Astronomical Society of the Pacific:—

| | Disappearance | | | Reappearance | | |
|---|---|---|---|---|---|---|
| | h. m. | " | ° | h. m. | " | ° |
| August 22 ... | 13 6 ... | 4·3 ... | 218 | 14 15 ... | 2·1 ... | 193 |
| ,, 31 ... | 14 11 ... | 3·0 ... | 211 | 14 59 ... | 1·8 ... | 193 |

The distances are measured from the planet's limb, and the position-angle from the N. point of the minor axis towards E. (the *Observatory*, No. 399, p. 326, August).

A Large Prominence.—In No. 1, vol. xxviii., of the *Astrophysical Journal* (July, p. 79), Mr. Evershed describes a large prominence of which a series of photographs was obtained with the Kodaikánal spectroheliograph on February 18. The first plate was secured at 8h. 23m. (Indian Standard Time), and showed no unusual disturbance, but a supplementary photograph at 9h. 38m. showed that a prominence faintly showing on the first plate had developed enormously, the disturbed area extending from position-angle 89° to 127°. Visual observations showed prominence matter on Hα, and the sodium and magnesium lines were also observed bright within the affected region. Twenty "limb" spectroheliograms were obtained during the day, the last being taken at 18h. 2m., when the sun was less than 3° above the horizon, and, of these, fourteen are reproduced. These show that the increase in size took place quite gradually, and that the velocity with which the great mass left the sun was, after the first outburst, consistently accelerating. The main mass of matter was joined to the sun by a fine filament, situated at the edge of the disturbed area, which appeared to act as a flexible cord holding one end of the mass to the sun and forcing it to swing out in a curve. The greatest height shown on the photographs was 585 seconds of arc, or more than 260,000 miles.

## THE WATER OF THE METROPOLIS.

THE report of the Water Examination Committee (July 18, 1908), and the first report on research work by Dr. Houston, the director of water examinations, Metropolitan Water Board, contain matter of considerable interest. The first details the results of the chemical and bacteriological examinations, many hundred in number, of the raw water and of the filtered supplies delivered to the consumers within the area of the Water Board for the year ending March 31, 1908. The matter is arranged in tabular form, and, *inter alia*, much information is given respecting the distribution and types of *Bacillus coli*, the effects of subsidence and filtration on the bacterial content of the water, and the composition of the media employed in bacteriological research in the Board's laboratories.

Dr. Houston's report deals with the important question of the vitality of the typhoid bacillus in artificially infected samples of raw Thames, Lee, and New River water, with special reference to the question of storage. Full details are given of the experimental methods employed. Taking cultures of 100 cubic centimetres of water as the final guide, it appears that, starting with an initial number of typhoid bacilli varying from 40 per c.c. to 8,000,000 per c.c. in the infected water, the typhoid bacillus could not be recovered from 100 c.c. of the water in any of the eighteen experiments after nine weeks, *i.e.* in this period the organism had died out so far as experiment could ascertain, and in sixteen out of the eighteen experiments the organism had died out in eight weeks. If, therefore, the water before distribution to the consumer could be stored for an adequate period, it would seem that the risk of conveyance of typhoid, supposing the water were infected, would be practically eliminated.

At present the Water Board's existing storage reservoirs are capable of holding in the aggregate 8883·7 million gallons, which is forty times the average daily supply of 219 million gallons, and powers have been obtained for the construction of storage reservoirs for another 6000 million gallons. When these are completed, the storage capacity would be adequate for the storage of the water for the eight or nine weeks necessary to eliminate the typhoid bacillus. Even in existing circumstances the conditions are by no means unsatisfactory. Unfortunately, however, the storage capacity at the different works is very unequal, and some have to take their water after only a limited period of storage. If the different reservoirs could be connected, and the supplies so "pooled," a better condition of things would result. Adequate storage of water also presents advantages of a general character, apart from the elimination of typhoid, *e.g.* subsidence of particulate matter which tends to block the filter-beds, reduction in the total bacterial content, &c.

R. T. H.

## SOME RESULTS OF THE NORWEGIAN HERRING INVESTIGATIONS.

"UNSERE Heringsstämme und ihre Wanderungen" is the title of a paper written for the Bergens Museum Aarbog, 1908, by Hjalmar Broch, dealing with some of the results of the Norwegian investigations into the herring fisheries. Extensive and detailed observations made by the *Michael Sars*, the Norwegian vessel for the international investigations, supplemented by information from other vessels, have yielded some valuable and interesting information as to this fish. One of the chief objects in view was to distinguish clearly the different races or varieties of herrings that are to be found in the North Sea, for it has of late been becoming more and more evident that each race of herring must be studied by itself, the characteristics and the direction and extent of the wanderings of the different shoals being very different. Following the method used by Heincke to accomplish this object, Broch has made a series of biometrical observations on numerous fish, and so determined their differences of structure, and these, accompanied by observations on sex, maturity, and fatness, have added considerably to our previous knowledge of the subject. Tables of the measurements are given, and the differences between the corresponding average measures on fish from different races, with their probable errors, are printed in the text, so that we are able at a glance to estimate the real significance of these differences. The inclusion of these in this form is of real value. For example, the differences between the averages of most races are considerably greater than their probable differences, but there is no conclusive proof as yet whether or not the varieties known as spring and large herring are really of the same race.

The following kinds of herring and their characteristics are now well known:—

(1) The Dogger Bank herring in the central North Sea.

(2) The Bohusläns herring in the Skager Rak.

(3) The Shetland herring in the northerly and westerly parts of the North Sea.

(4) The Norwegian spring and large herring along the Norwegian west coast and the north-easterly part of the North Sea.

(5) The Beitstad Fiord herring in Trondhjems Fiord.

There is a short section on the age investigations, which are as yet not advanced enough to give many results. Age is determined by means of the annual rings in the herring scales. An examination of plate ii. shows that the length of a herring is not by any means a simple function of its age, the growth rate being very different for the several kinds. The Beitstad Fiord herring, which is supposed to spend its whole life within the area of the fiord, is found to grow much more slowly than those races which frequent the open sea. In its fifth year it seldom exceeds a length of 22 cm., whilst the herrings of the Norwegian seas may become 24 or 25 cm. even in their second year.

The distribution of the various shoals and their movements at different times of the year have been studied. For instance, the spawning-places of the spring and large herring are found along the Norwegian coasts from Trondhjems Fiord to Risör, and the shoals gather here in early spring. The spent herrings then move into the open sea, and later in June they appear on the North Sea slopes. In autumn, 1905, they were discovered on the coastal banks between Stadt and Lofoten, whence in December they moved in a southerly direction towards the spawning-places along the coast.

The value of these investigations is not for the man of science alone; they are of great importance to the practical fisherman, who, knowing exactly when and where the various shoals spawn, is able to catch the herring when they are prime and avoid them in their spent condition. Many interesting questions, such as the relation of the herring migrations to the distribution of plankton, yet remain to be solved, and these must be the object of further investigations.

R. M. L.

## ARCHÆOLOGICAL RESEARCH IN INDIA.

A WRITER who has enjoyed unusually favourable opportunities of examining the conditions under which archæological research in India is being conducted has recently contributed to the *Times* a series of reports of his observations. Archæology in India is now at last, after a period of vandalism and neglect, being conducted on business and scientific principles. For this we are indebted to Lord Curzon.

The first serious attempt to collect information dates from the appointment, in 1862, of General Cunningham as Director of Archæology. Owing to the wide extent of the sphere of operations and the difficulty of securing the services of qualified assistants, the result was far from satisfactory. A long series of reports was issued, which, though they contain some valuable material, are ill-arranged and overloaded with useless matter. Besides this, under the régime of General Cunningham the work of conservation of existing buildings formed no part of the proceedings undertaken by the Government of India. After the retirement of General Cunningham little progress was made until, under Lord Curzon's scheme, in 1901 the post of Director was conferred upon Mr. J. H. Marshall, who, though without any Indian experience, had been trained in the Cambridge School of Greek Archæology. Since his appointment the work of conservation has gone on side by side with that of exploration, and important buildings like the Taj Mahal at Agra and the palaces at Fatehpur-Sikri have been judiciously restored. The most noteworthy excavations now in progress are those at the Buddhist monastery at Sarnath, near Benares, the buried city of Sravasti in northern Oudh, and the Græco-Buddhist remains in the neighbourhood of Peshawar. On the results of these excavations excellent periodical reports have been issued.

It is hardly realised what a wealth of archæological material still remains to be explored. Kapilavastu, the birthplace of Buddha, which lies just within the Nepalese Terai; Pataliputra, the Maurya capital, in the neighbourhood of the modern Patna; and numerous sites of the first importance in the Punjab and the United Provinces of Agra and Oudh, such as Taxila, near Rawalpindi, still await exploration. Research at many of these sites is certain to unearth inscriptions and sculptures which will serve to fill up many a gap in the early history of the country. The main hindrances to progress are at present:—first, the exclusiveness of both Hindus and Mohammedans, who object to the examination of buildings which are still used for worship; secondly, the fact that many important ancient buildings are situated within the territories of native States, where it has up to the present been impossible to arrange satisfactory schemes for conservation and excavation. In spite of these drawbacks, archæological research in India has now been placed upon a sound footing, and in the immediate future a large amount of fresh material, in the shape of sculptures and inscriptions, will be at the disposal of students.

## *ON ICE AND ITS NATURAL HISTORY*[1].

DURING the Antarctic cruise of the *Challenger* in the early part of the year 1874 I carefully examined the chemical and physical properties of sea ice. The melting temperature of the ice varied with the samples, but it was always below 0° C., and it was found impossible by any means to produce pure water by melting it. These two facts were for me convincing evidence, at that date, that the salt was present in the ice in the solid state, and that, consequently, the crystalline body, formed by freezing sea-water and similar saline solutions, was not pure ice.

About nine years later Dr. Otto Petterssen, having his attention directed in a similar way to the same subject, arrived at the same conclusion. His observations and their discussion are embodied in a remarkable paper on the properties of ice and water (Publications of the *Vega* Expedition, 1883). In the careful study which I made of this work the following passage arrested my attention:—"A thermometer immersed in a mixture of snow and sea water, which is constantly stirred, indicates $-1°.8$ C."

If this statement was exact, it was clear that the evidence furnished by the melting temperature of the sea ice was not entitled to the weight which I attached to it, and that the conclusion at which we had independently arrived was open to doubt. On repeating the experiment, I was able to confirm Petterssen's statement. I then proceeded to investigate the subject in detail. The principle which guided the investigation was the following:—if the crystalline body, which is formed when a non-saturated saline solution is partially frozen, is pure ice, then pure ice of independent origin, such as snow, must, when mixed with the same saline solution, and heat is supplied, melt at the same temperature when the concentration is the same.

This was found to be the case; and the result of the research was definitively to establish, on experimental evidence, the validity of the principle that, when a non-saturated saline solution is partially frozen, the crystals which are formed are pure ice; and, by consequence, that the salt from which it is, in practice, impossible to free them, belongs to the adhering brine.[2]

It was not until after this had been established, in 1887, that it became legitimate to say "the freezing point of *water* is lowered by the presence of salt dissolved in it," instead of saying "the freezing point of a *saline solution* is so much lower than that of pure water." The former of these statements expresses the fundamental principle of cryometric chemistry.

Shortly, *I define the freezing and melting temperature of a substance to be the temperature at which it as a solid passes into itself as a liquid, and as a liquid passes into itself as a solid.* In terms of this definition the freezing and melting temperature of the substance $H_2O$ is 0° C. In order to represent the *temperature at which ice melts*, this definition requires a double qualification. At constant pressure the temperature at which ice melts depends on the nature of the medium in which it melts, and if the nature of the medium be constant, the temperature at which ice melts depends on the pressure. Of the two modifying agencies, the influence of the medium preponderates in nature. Indeed, inasmuch as perfectly pure water is rarely, if ever, met with, it is probable that, *in nature, ice never melts and water never freezes exactly at* 0° C.

The principle that the temperature at which ice melts depends on the nature of the medium in which it melts is the key to the natural history of ice, and it forms the theme or text of this discourse. It at once brings into order the anomalies frequently observed in the experimental determination of many of the physical constants of ice, such as its coefficient of thermal expansion, its specific and its latent heat. When the ice or the water in which it is immersed contains any impurity, the temperature at which the ice begins to melt is below 0° C., and the substance under examination, which is taken for pure solid ice, is in reality a mixture of ice and impure water.

In discussing this subject, chloride of sodium is taken as the representative impurity, because it is the most widely disseminated ingredient of natural waters. It has also been more thoroughly studied than other salts in its behaviour to ice, water, and steam. In discussing the influence which this salt exercises over the apparent physical properties of ice a constant quantity of it is considered, and the quantity of ice on which it acts is varied. The constant quantity of the salt is 1·5105 grams, which contain 0·9167 gram of chlorine. The specific gravity of pure ice is taken as 0·9167 referred to that of water at the same temperature as unity.

It will be recognised that when 1000 c.c. of ice containing 1·5105 grams NaCl are melted, they furnish a water which contains chlorine in the proportion of 1 : 1000 by weight. The coefficient of cubic expansion by heat of pure ice is taken as 0·00016, and it is assumed to be constant at the temperatures under consideration. The volume occupied by the 1·5105 grams NaCl is disregarded. The cryohydric temperature of NaCl solution is taken as $-21°.72$ C., and its cryohydric concentration as 29·97 grams salt to 100 grams water.

Using these constants, we will apply the principle to the calculation of the apparent variations of volume of a block of ice the volume of which at 0° C. is 1000 c.c. It contains diffused through it 1·5105 grams NaCl, which we assume to be provisionally in the *inert* state, in which it is deprived of the power to induce the melting of ice at temperatures between 0° C. and $-21°.72$ C. Let the temperature of the block containing the inert NaCl be reduced to $-23°$ C.; its volume will be reduced to 996·320 c.c., and as the temperature is below the cryohydric temperature, the salt is by nature inert; at such temperatures ice and common salt are indifferent to each other. Let the temperature of the block of ice be now raised to $-22°$; the salt remains inert, and the volume of the ice increases to 996·48 c.c. If the temperature is further increased to $-21°.721$, the NaCl will still remain inert, and the volume of the ice will become 996·525 c.c.

If the heating is continued the temperature rises exactly to the cryohydric point, $-21°.72$, at which temperature the indifference of chloride of sodium to ice ceases, and induced melting at that temperature takes place. It will then be observed that the temperature remains constant for a time, while the volume of the block diminishes. When the temperature begins to rise, the volume of ice melted will be 5·498 c.c. As this produces 5·040 c.c. water, the diminution of volume is 0·458 c.c., and the apparent volume of the block is 996·067 c.c.

Let us now go back to the initial state, in which we have the block of 1000 c.c. ice, containing 1·5105 grams inert NaCl diffused through it, at the temperature 0° C. Let the temperature be reduced to $-21°$ C., the ice remaining inert. The volume of the ice will then be 996·64 c.c. Let the NaCl recover its activity, it will melt 5·629 c.c. ice, producing 5·160 c.c. water under a contraction of 0·469 c.c., so that the apparent volume of the ice at $-21°$ C. is $996·64 - 0·469 = 996·171$ c.c. Proceeding by steps in this way, we obtain, for different temperatures $t$, the volume of the ice containing inert salt V, the volume of ice melted by the salt when its activity is

[1] Abridged from a discourse delivered at the Royal Institution on Friday evening, May 8, by J. Y. Buchanan, F.R.S.

[2] The results of the research which I began in the year 1886 were communicated to the Royal Society of Edinburgh in a paper "On Ice and Brines," which was read on March 21, 1887, and was published in the Proceedings of the Society, vol. xiv., pp. 129–149. A full account of it was also published in NATURE, 1887, vol. xxxv., p. 608, and vol. xxxvi., p. 9. The whole subject of the influence of dissolved salt on the state of aggregation of the substance $H_2O$ at temperatures below its normal freezing and melting point and above its normal boiling and condensing point was passed in review in my chemical and physical notes in the "Antarctic Manual," 1901, pp. 73–108.

restored $v$, the contraction so produced $c$, and the resulting apparent volume of the ice $U = V - c$. The values of $v$ are derived from the observed freezing points of specified NaCl solutions. The results calculated for certain values of $t$ are given in Table I.:—

TABLE I.

| $t$ | V | $v$ | $c$ | U | $t$ | V | $v$ | $c$ | U |
|---|---|---|---|---|---|---|---|---|---|
| C. | c.c. | c.c. | c.c. | c.c. | ° C. | c.c. | c.c. | c.c. | c c. |
| −23 | 996·320 | 0 | | 996·320 | −8 | 998·720 | 12·531 | 1·044 | 997·676 |
| −22 | 996·480 | 0 | | 996·480 | −7·2 | 998·848 | 13·884 | 1·157 | 997·691 |
| −21·721 | 996·520 | 0 | | 996·520 | −7·0 | 998·880 | 14·195 | 1·183 | 997·697 |
| −21·72 | 996·520 | 5·498 | 0·458 | 996·067 | −6·8 | 998·912 | 14·628 | 1·219 | 997·693 |
| −21 | 996·640 | 5·629 | 0·469 | 996·171 | −1·0 | 999·840 | 98·350 | 8·196 | 991·644 |
| −20 | 996·800 | 5·825 | 0·485 | 996·315 | −0·1 | 999·984 | 998·35 | 83·196 | 916·788 |

If we study this table we see that *between the temperatures $-23°$ and $0°$ the coefficient of apparent dilatation of the ice changes sign three times—namely, twice at the cryohydric temperature, and once at a higher temperature.* Between $-23°$ and the cryohydric point $-21·°72$ the expansion is uniform, the coefficient being 0·00016. At the cryohydric point the addition of heat produces contraction without change of temperature; the coefficient, therefore, is $-x$. Above the cryohydric temperature the volume increases with the temperature, but at a gradually diminishing rate, until at $-7°·0$ the increase of volume due to simple expansion of the ice is exactly balanced by the contraction due to induced melting. At this temperature the coefficient of expansion changes sign, and between $-7°·0$ and $-0°·1$, at which the ice has practically all melted, the coefficient of expansion is negative.

If the block of ice contained salt in the proportion 29·97 grams NaCl to 100 grams ice, it would expand uniformly on being warmed from $-23°$ to $-21°·72$, and would then melt completely at that temperature. In the same way, if it contained no salt or impurity whatever, it would, on being warmed, expand uniformly, while its temperature rose, until, at 0° C., it would melt completely. If the ice contains salt in a less proportion than 1·7164 : 100 by weight, then we witness the three changes of sign in the coefficient of dilatation when the temperature rises from below the cryohydric point to the temperature at which the ice is finally liquefied. When the block contains, per 100 parts by weight of ice, less than 29·97 and more than 1·7164 parts of NaCl, the coefficient of apparent expansion is negative at all temperatures above $-21°·72$.

In Table II we have the upper critical temperature ($\tau$) at which the coefficient of apparent dilatation changes sign for blocks of ice having volumes ranging from 100 cubic centimetres to 100 cubic metres, each containing 1·5105 grams NaCl. Under $V_0$ we have the initial volume of the block of ice supposed pure and solid at 0° C., and under $v$ the volume of ice which can be melted under the inducing influence of 1·5105 grams of chloride of sodium at the critical temperature $\tau$, at which the apparent coefficient of cubic expansion of the ice is equal to 0.

TABLE II.

| $V_0$ | $v$ | $\tau$ | $V_0$ | $v$ | $\tau$ | $V_0$ | $v$ | $\tau$ |
|---|---|---|---|---|---|---|---|---|
| c.c. | c.c. | ° C. | c.c. | c.c. | ° C. | c.m. | c.c. | ° C. |
| 100 | 5·73 | −20·5 | 1000 | 14·20 | −7·0 | 0·01 | 41·83 | −2·3 |
| 200 | 6 74 | −16·6 | 2000 | 20·00 | −4·9 | 0·1 | 136·3 | −0·725 |
| 400 | 9·85 | −10·75 | 4000 | 27·80 | −3·5 | 1·0 | 438 | −0·2275 |
| 600 | 11·75 | − 8·65 | 6000 | 32·24 | −2·95 | 10·0 | 1377 | −0·0725 |
| 800 | 12·85 | − 7·8 | 8000 | 37·57 | −2·55 | 100·0 | 4306 | −0·02275 |

A block of 100 c.c. of ice, which contains 1·5105 grams of NaCl diffused through it, furnishes on being melted 91·67 c.c. of water, which contain 0·9167 gram of chlorine, dissolved in it as chloride of sodium. This water contains chlorine in the proportion 1 gram to 100 grams of water, and represents a concentration about one-half that of average sea water. When the volume of ice, $V_0$, is 1 cubic metre, the water produced by its melting contains chlorine in the proportion of one part to one million parts of water by weight.

Waters which contain dissolved matter equivalent to no more than 1 gram of chlorine in 10,000 grams of water are in the category of ordinary fresh waters, and we see that the critical temperature of ice which furnishes such water lies as low as $-2°·3$. When the dissolved matter is equivalent only to 1 gram of chlorine in 100,000 grams of water, the critical temperature is $-0°·725$. The other waters are in the category of distilled waters, and it is doubtful if, by any chemical means whatever, we could determine as little dissolved matter as 1 gram chlorine in one ton of water; yet the critical temperature of such ice lies nearly a quarter of a degree below the melting temperature of pure ice. The critical temperature of expansion of ice affords a means of detecting impurity equivalent to quantities of chlorine as small as one gram in ten tons, and even one gram in one hundred tons of water.

*Influence of Impurity on the Apparent Latent Heat of Ice.*

This is illustrated by the numbers in Table I. Thus, at $-1°$ C., the apparent volume of the block of ice is 991·644 c.c., and it is made up of 901·49 c.c. ice and 90·154 c.c. water. When this is warmed to $-0°·1$, we may take it that the whole of the ice is melted. Taking the latent heat per unit volume of ice as 66·5 at $-0°·1$, and its specific heat per unit volume as 0·45, the heat required to raise the ice from $-1°$ to $-0°·1$ is 365·1 gram-degrees (gr.°); that required to raise the temperature of the water by the same amount is 81·14 gr.°, and the heat required to melt the ice at $-0°·1$ is 59949 gr.°, the total heat used being 60395·2 gr.°. If we ignore the possibility of partial melting, and assume that we have 999·84 c.c. solid ice at $-1°$, and that its temperature is raised to 0°, at which temperature it melts, we have the following expenditure of heat:—for rise of temperature 449·9 gr.°, and for melting 66489·3 gr.°, making together 66939·2 gr.°, as against 60391·5 gr.°. If from 60395·2 gr.° we deduct the heat calculated for warming the ice in the second case, 449·9 gr.°, we obtain 59945·4 gr.° as the heat required to melt 1000 c.c., or 916·7 grams, of ice at 0°, whence the latent heat would be, per unit volume, 59·94, and per unit weight 65·39.

This example illustrates also the effect of impurity on the apparent specific heat of ice.

*The nature of the medium is responsible* in the case of sea ice for depressions of freezing and melting temperatures of thirty, forty, or even more degrees of Celsius's thermometer, while the greatest pressure to which freshwater ice is exposed in nature cannot produce an alteration of freezing and melting point amounting to much more than one degree.

If we pick up a piece of ice floating in the Polar Sea we know that it will prove to be very far from homogeneous. It may have a foundation of genuine primary sea ice, but the ice forming the superstructure is sure to consist of snow, frozen spray, and very likely fragments of land ice, all cemented together into a species of conglomerate. When this is exposed to warmth it begins to melt at a temperature which may be one or two degrees below the melting point of pure ice, and the liquid so furnished is salt water. The further melting takes place in ascending order of temperature, the salt ice of low melting point disappearing first, and the purer ice melting later. We thus see how ice can be cemented by ice, just as metallic objects may be united by solder. In both cases the substance of the binding material differs from that of the objects united, chiefly in being more easily fusible.

If we have a number of cubes of pure ice which fit each other exactly, and if, after being moistened with salt water, they are exposed to frost, they will solidify to a single block. If this be exposed to the sun the cementing salt ice will melt first, and, when it ceases to bind, the constituent cubes of pure ice will fall asunder, having themselves suffered practically no diminution due to melting.

Now this is precisely what happens when a block of sound glacier ice is exposed to the rays of the sun for a short time, and it is one of the most striking and instructive experiments that can be made. Under the influence of the sun's rays, the binding material melts first, the continuity of the block is destroyed, the individual grains become loose and rattle if the block be shaken, and, finally, they fall into a heap. A block of glacier ice is a geometrical curiosity. It consists of a number of solid bodies of different sizes and of quite irregular shapes, yet they fit into each other as exactly and fill space as completely as could the cubes above referred to.

Particulars with regard to the size of the grain of the Aletsch and the Bossons glaciers will be found in an article in NATURE (1901), vol. lxiv., p. 399.

*Disarticulation of the Grains of the Glacier by Solar Radiation.*

In the Mergelin See, glacier ice can be studied in a way that is possible in no other place. The fragments of the Aletsch Glacier which float in it are veritable icebergs. In the middle of summer they are exposed to a very powerful sun, and the weathering and disintegration, as well as the melting, proceed at a very rapid rate.

The action of the sun's rays on glacier ice is two-fold; it disarticulates the ice into its constituent grains, and it splits the individual grain up into laminæ perpendicular to the principal axis of the crystal, and bounded by the planes of fusion described by Tyndall. These planes are the distinguishing characteristic of the individual ice-grain.

Under the influence of radiant heat an ice-grain begins to melt at the surfaces which separate these laminæ, and the process of disintegration and decay is directed by their plane. On the other hand, an ice-grain, floating in water and losing heat, generates ice laminæ which are directed by the same planes, which form the continuation of the corresponding laminæ of the parent crystal. As the grains in a block of glacier ice are distributed quite irregularly, the water-line of a floating block necessarily cuts a great number of grains, all of which are oriented differently. The ice which is formed during the night along this line is oriented crystallographically by the grain with which it is in contact, and from which it appears to spring in continuation of its crystalline laminæ. This produces a remarkable pattern of lines on the surface of the lake ice contiguous to a block of glacier ice.

Tyndall has described and figured the minute features of the disintegration of the crystal under the absorption of radiant heat. Similar and complementary features are observed when ice is generated from an existing crystal under the dissipation of heat. To do justice to them, however, would require the services of a skilful, patient, and resourceful artist.

The disarticulating and analysing action of the sun's rays is not accomplished without selection and the expenditure of energy. Accordingly we observe that one grain protects another. The disarticulation into separate grains, although very thorough near the surface of a glacier, does not penetrate far. A stroke or two with an ice-axe reveals the fresh blue ice. In the case of an iceberg, whether floating in a lake or in the ocean, only the grains that are exposed to the sky and above water are disarticulated, and prolonged exposure of this kind reduces a grain to the last stage of dilapidation. The grains beneath the surface, *whether of ice or water*, are almost completely unattacked.

The importance of direct skylight for the disarticulation of glacier ice into its constituent grains is very well seen in the artificial grottos which are maintained at easily accessible parts of most popular glaciers. The thickness of the layer of completely disarticulated ice is so small that it is hardly noticed, and the whole grotto appears to be cut out of pure blue ice. If the observer, on penetrating for a few paces, turns round and looks outwards, he sees the surface of the ice-walls of the grotto etched with strange line figures. These are most strongly marked near the opening, and they extend as far as direct skylight strikes the ice. The lines so developed are formed by the intersection of the surface of the ice-wall of the cave with the separating surfaces of contiguous ice-grains. The picture thus presented is one of very great interest.

*Delineation of the Grain by Hoar-frost.*

After the autumnal equinox very little melting of ice takes place, and by the end of October it has, as a rule, ceased entirely. The etched figures on the walls of the entrance of the grotto, which were developed by solar radiation during summer, disappear quickly with the arrival of winter; but the winter brings with it another means of delineation of the grain which does not depend on solar radiation. Even at the lowest of winter temperatures the atmosphere contains vapour of water, which it is prepared to relinquish under the same conditions as those under which dew is formed in summer. In the Alpine winter, however, it is deposited, not as dew, but as rime, that is, not as water, but as ice. It is well known that very fine etching on a polished surface, which can with difficulty be seen without assistance, at once becomes visible if the surface be breathed on. In winter

Grain of the glacier on the roof of the grotto in the Morteratsch Glacier elineated by hoar-frost, January, 1907.

the walls and roof of the grotto are cold, dry, smooth, and polished like glass. The winter air entering from without and circulating in the grotto *breathes* on the polished surface of ice and develops the figure of the ice by the rime which is deposited on it. As rime always settles by preference on sharp edges, it seeks out the lines of separation between the grains and settles on them, showing the whole granular structure. In January, 1907, there was a wonderful exhibition of this natural damascening on the roof of the cave of the Morteratsch glacier; in January, 1908, however, it was quite inferior, and would not have struck the eye. The illustration represents a portion of the roof of the cave which I photographed in January, 1907. As the roof is not flat, but made up of shell-like cavities worn by the hot air in summer, the delineation of the grain is sharp in some parts of the photograph and faint in others.

A precisely similar phenomenon was observed in 1886 by Prof. Forel in the remarkable natural grotto of the Arolla glacier, of which he has given so fascinating a description in the *Archives des Sciences physiques et naturelles, Genève,* 1887, xvii., p. 498. The delineation of the etched figures by rime was observed by him in the month of July in a remote and secluded chamber nearly 250 metres from the entrance of the grotto. In artificial grottos like that of the Morteratsch glacier, in which the air circulates freely, the hoar-frost disappears very quickly with the end of winter.

*The Grain of Lake Ice.*

It is not glacier ice alone which suffers disintegration when exposed to a powerful sun. Lake ice behaves in a similar way. Beautiful examples of this can be seen in Alpine seas every winter. During the harvesting of the ice from the lake, the blocks often lie for a day or more before they are carted away to the ice-houses. Occasionally some of them get overlooked and remain for many days exposed to the powerful sun of February, while maintaining the low temperature of the air usual in that month. No melting takes place, but after even a few hours' exposure to the sun the block shows the figure of its grain in development. It is being etched by the sun's radiation.

The grain of lake ice has a very different appearance from that of glacier ice, but both are individual crystals. The difference in their appearance is to be traced to the difference of treatment which they have received during their existence. The glacier grains have been practically rolling over each other during their descent, while those of the lake have established themselves at right angles to the surface of the water, and have remained there. So long as the ice is increasing in thickness, the temperature of its upper surface is very low. It is perfectly transparent, and its surface is smooth, dry, and polished like glass, and it shows no trace of crystalline figure. When the ice is undisturbed this develops itself only at the end of the season when the thaw sets in. Then the whole ice-sheet rises to its melting temperature, and is at the same time exposed to the direct radiation of the sun. This produces disarticulation of the ice into groups of vertical prisms which are then floating independently; they are kept together only by crowding. Ice in this state is said to be rotten; and it will be recognised that, however thick the ice-sheet may be, when it gets into this condition it is dangerous. In the neighbourhood of the outflow the crowding is relieved, the disarticulated groups become disengaged, the smaller groups and individual prisms are able to assume their attitude of stability and to float on their sides. All then drift towards the outlet. The ice "breaks up," and the lake is cleared in an astonishingly short time.

If it were not for the law that even impure water in freezing always forms pure ice, the impurity remaining in the liquid and generally entangled in the interstices of the grains, and that the pure ice which is in contact with this impure liquid melts at a lower temperature than that which is in contact with nothing but the water formed by its own melting, the ice-covering of a lake would be a continuous sheet offering no points of weakness, and it would have to melt as a whole. It is doubtful if lakes such as those, met with in the Upper Engadine, would get rid of their ice-covering at all. On the Silser See the ice is usually more than 60 centimetres thick when the thaw sets in, but when once the ice begins to break up the lake is cleared in a day. Sixty centimetres of ice would take a long time to disappear on the basis of surface melting alone.

While the winter lasts, the ice on the lake shows no crystalline structure. This develops only after removal from the water and exposure to the sun. The ice then splits up into prisms in a vertical plane. These are at first of irregular section, and as sun-weathering proceeds the thicker prisms split up into thinner. When a block has lain exposed to the February sun and cold it may fall to pieces, each piece being a long, thin, triangular prism, with some resemblance to a razor-blade. When the ice is cold and dry the outlines of the grains are lines; when the ice has a temperature of 0° C. it melts preferably round the grain, forming troughs in which the water collects, and the aspect is that of a dark polygon surrounded by light-coloured canals. The columnar grains have their striation like those of the glacier. In one piece, which was much weathered, I counted twenty-four such grains in an area of 9 square centimetres. In a slab which had not been lying long I counted twenty-three grains in an area of 150 square centimetres, giving an average area of 6·5 square centimetres per grain; the largest had an area of 12 square centimetres. In another slab there was a very large grain which measured 7 centimetres in one direction and 4 centimetres at right angles to it. In a slab in which the sun-weathering had proceeded very far I counted 113 grains in a disc of 5 centimetres radius, which gives 0·69 centimetre as the average area per grain.

In the absence of actual experience, one is apt to expect a slab of lake ice, when subjected to sun-weathering, to be disarticulated into hexagonal columns; but this expectation is quite gratuitous. Ice may crystallise in a form bounded by plane faces, according to the laws of its crystallographic system, if it has the freedom which it possesses when crystallising out of an independent medium such as a saline solution or air. But the foreign matter dissolved in fresh water is present in so small quantity that what we have before us is the solidification rather than the crystallisation of ice, and each column as it tries to develop itself is interfered with by its neighbour, and the resulting slab of ice is made up of elementary prisms crowded together, but preserving parallelism of crystallographic axis.

The second part of the discourse dealt with the part played by glaciers and rivers in modifying the features of the surface of the earth, but it cannot be usefully condensed so as to be included in this communication.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE University of Jena, at its recent jubilee, conferred the degree of M.D., *honoris causa*, on Sir William Ramsay, K.C.B., F.R.S.

MR. W. J. HORNE, lecturer in physics at the South African College, Cape Town, has been appointed to the inspectorate of the Transvaal Department of Public Education as organiser for technical education.

UPON the authority of the *Cologne Gazette*, a Reuter correspondent states that the question of the admission of women to university study in Germany has been settled. Women who are subjects of the German Empire will be admitted on the same footing as men, but women of other countries will require the permission of the Minister of Public Instruction for matriculation.

A PAPER on the educational aspect of domestic subjects was read recently by Prof. A. Smithells at Bradford, the occasion being the fourth annual meeting of the Northern Union of Domestic Economy Associations. A verbatim report appears in the first August number of *Education*, and we learn therefrom that Prof. Smithells considers that the increased attention being paid to the teaching of domestic subjects is very gratifying. He wishes to bring such subjects within the purview of universities, as it is desirable to connect every branch of education with what should be the most abundant and vivifying springs of knowledge. The introduction of domestic subjects into the normal educational curriculum for girls would add a much wanted ingredient, as in the household arts we have a direct educational instrument for conferring upon girls the very great gift of manipulative skill, and of doing it by teaching the very work that will lie nearest to them in their normal daily life when they have left school. Domestic subjects include much that affects the cultivation of the moral and æsthetic side of human nature, and a good teacher will make them mentally stimulating.

THE *Revue scientifique* for August 8 reproduces the address given by Prof. Paul Appell, the president of the French Association for the Advancement of Science, at the meeting at Clermont-Ferrand on August 3. As we mentioned in our issue of August 13, the address deals with the teaching of science and the formation of the scientific spirit, and insists on the necessity of the latter as the foundation for those powers of initiative and of intelligent activity without which progress is impossible. Prof. Appell points out that the object of higher education is three-fold—to make, to teach, and to apply science—and considers in detail how far the educational system of France attains these objects. He finds much overlapping, and directs special attention to the large amount of teaching of pure science which goes on in technical schools the principal function of which, he urges, should be to teach technical applications to pupils already well grounded in science at the universities or other schools of university type. Those interested in higher education in this country will find much food for thought in Prof. Appell's address, and many will ask, Are our institutes for higher education carrying out their duty of making science as they ought? while more will want to know how much of the energy of our polytechnics and technical schools is devoted to teaching pupils the laws of motion or how to solve simple equations.

THE latest article of a series published by the *Times* on American life is devoted to "Colleges and Character." After mentioning the rapid growth of the universities, which in 1904 already had 119,496 undergraduates, the writer agrees with the Rhodes scholar who reported that from the sole standpoint of scholarship it was not necessary for him to leave America. On the other hand, the author of the article lays blame on the "elective" system, which presupposes that the average youth of eighteen, fresh from school, has defined aptitudes, understands himself, has adequately given shape to his ultimate purpose, and can be depended upon to select the studies best adapted to the achievement of his destiny. Nevertheless, he considers that the fundamental idea of electives is sound, but that the reaction from the old rigid courses of instruction has gone too far. A student may graduate by passing in four entirely disconnected subjects in each of four successive years; moreover, there is a temptation to seek "soft options." On the other hand, we may observe that it is commoner in America to find commercial men who, by pursuing the somewhat haphazard sampling of studies which the elective system permits, have acquired intelligent appreciation of, say, comparative religion and Röntgen rays. In England men of the same class rarely attempt any university study. The author expects that "electives" will never be disallowed in the future, but will be intelligently restricted, so as to secure that all students—not merely such as choose—will be subjected to the discipline proper to university life on its intellectual side.

## SOCIETIES AND ACADEMIES.

### LONDON.

Royal Society, June 18.—"An Electrical Method of Counting the Number of $\alpha$ Particles from Radio-active Substances." By Prof. E. **Rutherford**, F.R.S., and Dr. H. **Geiger**.

(1) By employing the principle of magnification of ionisation by collision, the electrical effect due to a single $\alpha$ particle may be increased sufficiently to be readily observed by an ordinary electrometer.

(2) The magnitude of the electrical effect due to an $\alpha$ particle depends upon the voltage employed, and can be varied within wide limits.

(3) This electric method can be employed to count the $\alpha$ particles expelled from all types of active matter which emit $\alpha$ rays.

(4) Using radium C as a source of $\alpha$ rays, the total number of $\alpha$ particles expelled per second from 1 gram of radium have been accurately counted. For radium in equilibrium, this number is $3{\cdot}4\times10^{10}$ for radium itself and for each of its three $\alpha$-ray products.

(5) The number of scintillations observed on a properly prepared screen of zinc sulphide is, within the limit of experimental error, equal to the number of $\alpha$ particles falling upon it, as counted by the electric method. It follows from this that each $\alpha$ particle produces a scintillation.

(6) The distribution of the $\alpha$ particles in time is governed by the laws of probability.

The authors have previously pointed out that the principle of magnification of ionisation by collision can be used to extend widely the already delicate methods of detection of radio-active matter. Calculation shows that under good conditions it should be possible by this method to detect a single $\beta$ particle, and consequently to count directly the number of $\beta$ particles expelled from radio-active substances.

Further work is in progress on this and other problems that have arisen out of these investigations.

### EDINBURGH.

Royal Society, July 13.—Prof. Crum Brown, vice-president, in the chair.—An improved method of esterification: G. E. **Gibson**.—Nitric anhydride as a nitrating agent: G. E. **Gibson**.—The significance of maximum electrolytic conductivity: Prof. John **Gibson**.—The variation of Young's modulus under an electric current, part ii.: Henry **Walker**. In these experiments it was shown that the curious changes in the value of Young's modulus when the iron, steel, copper, or platinum wire was heated by an electric current were not observed when the wire was stretched under a load approaching the limits of elasticity, and that when the wire was heated by ordinary methods no peculiarity in the change of Young's modulus was found to exist.—The theory of general determinants in the historical order of development up to 1860: Dr. Thomas **Muir**.

July 20.—Dr. R. H. Traquair, vice-president, in the chair.—A sensitive state induced in magnetic substances and materials by thermal treatment, part ii.: J. G. **Gray** and A. D. **Ross**. The sensitive state induced by annealing the material from moderately high temperatures was reduced by jarring, but could not be completely obliterated by this means. A strong sensitive state was induced when the material was cooled from room temperature to that of liquid air, or when it was heated from the temperature of liquid air to that of the room; but when the material was cooled to the temperature of liquid air and then heated again, only a small increase was observed in the susceptibility. The effect was associated with temperature change, and was not apparently influenced by the length of time the material was kept at the high or low temperature.—The structure of *Turrilepas peachi* and its allies: F. R. Cowper **Reed**. An examination of type-specimens from Whitehouse Bay and of further material shows that the organism is bilaterally symmetrical. There are four series of plates, a double median longitudinal row of small triangular plates in close contact overlying the larger and more elongated lateral kite-shaped plates. The latter are arranged in pairs on each side, extending (in the middle part of the body) nearly at right angles to the axial line, but becoming inclined more acutely forwards towards the anterior end. The lateral plates also overlap each other for about half their width, and bear on their outer surface a median longitudinal impressed narrow groove which appears as a fold on the reverse side of the plates. The characters of *Turrilepas scotica* were discussed in the light of the newly discovered structure of *T. peachi*, and of fresh material from the Balcletchie beds, and the Scottish species were compared with the undescribed forms from the Ordovician beds of England and Wales, and with the American genera Strobilepis and Lepidocoleus.—The recalescence of nickel: T. A. **Lindsay**. Two cylinders, one of nickel and one of copper, were allowed to cool simultaneously from a high temperature, the difference of temperature at each instant of time being measured by a thermoelectric couple with the two junctions in the heart of their respective cylinders. The difference curve of cooling so obtained indicated recalescence phenomena at temperatures of 650° C., 515° C., and within the range 370° C. to 285° C.—Note on the study of polarisation by means of the Dolezalek electrometer: A. F. **Ewan**. The method afforded a very delicate test of the independence of polarisation on the potential of the electrode, and it was also found possible to extend the time curve of polarisation through a much greater range than had been possible with any one of the other methods. Interesting corroboration was obtained of Bouty's and Wiedeburg's formulæ.—Preliminary note on the action of nitric anhydride on mucic acid: Prof. Crum **Brown** and G. E. **Gibson.**—The meteorology of the Weddell quadrant and adjacent areas: R. C. **Mossman.** This was a general discussion, restricted to the more prominent elements of climate, of the meteorological conditions of Antarctic and sub-Antarctic latitudes, with the aim of correlating the weather changes of these adjacent regions.

### PARIS.

**Academy of Sciences,** August 10.—M. Maurice Levy in the chair.—A problem relating to the theory of orthogonal systems and to the method of the mobile trihedron: Gaston **Darboux.**—Complement to an earlier note on the manner in which the changes in magnitude of the two right lines joining the sun and a planet to the earth are related to their changes in direction when the planet moves in the plane of the ecliptic: J. **Boussinesq.**—The registration of the upper layer of calcium in the solar atmosphere: H. **Deslandres** and L. **d'Azambuja.** A special study has been made of the calcium line $K_3$. The dark calcium filaments appear in all latitudes, and are clearest at the edges. They are the seat of considerable radial movements. The filaments, which form the principal character of the upper layer of the solar atmosphere, are evidently related to the general circulation of the vapours, to the accidental variations of their velocity of rotation, and possibly also to the formation and dissipation of faculæ.—The rotation of the sun: A. **Perot.** An application of the method of interference spectroscopy devised by the author and M. Fabry to the lines of wave-lengths (Rowland) 5202·4, 5349·6 (Ca), 6065·7 (Fe), and 6122·4 (Ca), the angular velocities and times of revolution of which are given. The equatorial acceleration is very marked for the two calcium lines studied, whilst the two others are normal in this respect. —Equations all of whose roots are real: A. **Pellet.**—Some remarkable movements: M. **Haag.**—The action of the radium emanation on solutions of copper salts: Mme. **Curie** and Mlle. **Gleditsch** (see p. 372).—A new application of superposition without confusion of small electric oscillations in the same circuit: E. **Mercadier.** The signals are produced by alternating currents controlled by electro-diapasons, and are received on vibrating plates tuned to exact unison. It has been found possible to superpose in the same circuit simultaneously and in both directions the signals arising from twelve electrodiapasons on lines from 5 to 700 kilometres in length. Messages on this system have been successfully exchanged between Paris and Marseilles.—The physicochemical analysis of wines: Paul **Dutoit** and Marcel **Duboux.** An application of D. Berthelot's method of electrical conductivities to the titration of acids and bases in wines.—Researches on the cause of the odour acquired by air submitted to the ultra-violet radiations emitted by a mercury vapour lamp: H. **Bordier** and T. **Nogier.** It is definitely proved that this odour is not due either to the production of ozone or nitrous fumes. The circulation of gases free from oxygen, such as nitrogen or carbon dioxide, causes the same odour.—The intradermo-reaction of tuberculin: Ch. **Mantoux.** Details are given of the method of applying this test, which has been compared in fifty-two cases with the cuti-reaction. The test failed in only two cases, and has the advantages of simplicity of execution and greater sensibility.—The culture of the virus of fowl plague *in vitro*: E. **Marchoux.** This disease is one in which no organism has been detected, probably on account of its extreme minuteness. It has been reproduced in ten successive stab cultures, retaining its virulence.—Contribution to the study of the Continental *facies*: Palæozoic landslips: Stanislas **Meunier.**—The kaolin-bearing rocks of the basin of Lake Nepigon, Canada: F. Romanet **du Caillaud.**

### GÖTTINGEN.

**Royal Society of Sciences.**—The *Nachrichten* (physico-mathematical section), part ii. for 1908, contains the following memoirs communicated to the society:—

July 27, 1907.—Records of the specific conductivity of atmospheric air: H. **Schering.**

February 21, 1908.—Determination of the vertex and apex (of the stellar system), on the ellipsoidal hypothesis, from a small number of observed proper motions: K. **Schwarzschild.**

March 7.—Seismic records in Göttingen for 1906: K. **Zoeppritz.**

March 21.—The generation of linear ternary substitutions from a minimal number of fundamental substitutions: W. Fr. **Meyer.**

The business communications of the society, part i. for 1908, include a report on the Samoa Observatory for 1907, the address presented to the University of Upsala at the Linnæus celebration, and a memorial notice of Lord Kelvin by W. **Voigt.**

### CAPE TOWN.

**Royal Society of South Africa,** July 15.—Mr. S. S. Hough, F.R.S., president, in the chair.—Preliminary note on the diurnal variation of level at Kimberley: J. R. **Sutton.** This paper gives the preliminary results of observations made during the course of three years upon the variation of the level of the ground as recorded by a large horizontal pendulum of a special design made for the author by the Cambridge Scientific Instrument Co. It appears from the results that the movements in the surface of the ground which set up corresponding movements on the pendulum at Kimberley are very great. The maximum westerly elongation of the extremity of the pendulum occurs about $5\frac{1}{2}$ a.m., the maximum easterly about $4\frac{1}{4}$ p.m., the median positions a little before 11 a.m. and $9\frac{1}{2}$ p.m. Geometrically these movements may be represented on the hypothesis that the hemisphere facing the sun bulges out, forming a sort of meniscus to the geosphere. The enormous rise and fall of the surface of the land that such a supposition would postulate are, however, mechanically difficult. The range of the pendulum's excursion from west to east during the day is twice as great in winter as it is in summer.

## CONTENTS.

THURSDAY, AUGUST 27, 1908.

## *FLUID RESISTANCE AND SHIP PROPULSION.*

*Resistance of Ships and Screw Propulsion.* By Naval Constructor D. W. Taylor, U.S.N. Pp. ix+234. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1907.) Price 10*s.* net.

A TEXT-BOOK dealing with these subjects, on the basis of scientific principles and experimental investigation, in a form suitable for the use of students, was much required when, fifteen years ago, Naval Constructor Taylor undertook the task. He was exceptionally qualified for the work, having graduated at the Naval Academy at Annapolis, and subsequently passed, with distinction, through the courses of study in naval architecture at the Royal Naval College at Greenwich, where he had the great advantage of attending lectures by Prof. Cotterill, F.R.S., and the instructors in naval architecture. Mr. Taylor's book was largely in the nature of a compilation, and based on work done by British writers, and especially on that of William Froude and Rankine. Due acknowledgment of this indebtedness was made, but the volume also contained much original work. Its presentation of facts and principles was fresh and admirable in form. The style was clear and terse; mathematical investigations were numerous and well arranged; readers were referred to original sources of information; and within two hundred pages a great mass of information was compressed. In these circumstances it was natural that the volume should be widely circulated both in this country and in the United States. It has been out of print for some years, and all interested in these subjects have hoped for a revised edition in which would be embodied work done since 1893 in connection with the resistance and propulsion of ships. The intervening period has been marked by numerous and valuable experimental investigations conducted in tanks which have been established in this country and abroad on the model of that first constructed near Torquay by the late William Froude about forty years ago.

One of the best equipped experimental establishments of this kind is that in the Washington Navy Yard, over which Mr. Taylor has presided, and for the designs of which he was largely responsible. It is much to be regretted, therefore, that the pressure of his official duties should have prevented Mr. Taylor from re-writing his book and bringing it up to date. This is particularly true in regard to the sections of the work which deal with screw-propellers. Mr. Taylor has conducted some of the most important series of experiments on model propellers yet made, and his papers published in the Transactions of the British and American Societies of Naval Architects are both valuable and suggestive. Had it been possible for him to summarise and digest his own results and those obtained by Mr. R. E. Froude, Prof. Durand and other experimentalists, he would have conferred a great service on all who are connected with ship propulsion. It may be hoped that he will yet attempt this task, for which no living writer on the subject is better qualified.

Taking the book as it stands, as an avowed reprint, it will be welcomed by shipbuilders and marine engineers, who will find therein an excellent epitome of modern theories of resistance and propulsion, and useful illustrations of the applications of these theories in practical ship-designing and the estimate of engine-power required for given speeds. Outside professional circles there are many persons interested in problems of fluid resistance who will be glad to have an exposition of the modern experimental methods which we owe chiefly to the Froudes, and a sketch of the stream-line theory of resistance on which those methods are based.

Thanks to the generosity of Mr. Yarrow, who has himself been responsible for the production of many vessels of exceptional speed and novel type, there is now a practical certainty of the establishment at an early date, in connection with the National Physical Laboratory, of an experimental tank embodying all accumulated experience and having the most modern and perfect equipment. It is true, no doubt, that the results of model experiments can only be applied within certain limits, and that they must be associated with analyses of full-scale trials of ships and propellers. The experience of forty years on the lines laid down by William Froude has established the enormous value of his experimental method in the design and propulsion of steam-ships of novel types and unprecedented speeds. There remains, however, the necessity for more extended research in order that the influence of variations in forms and proportions of ships and the characteristics of screw-propellers may be better understood. Large economies are undoubtedly still possible in the propulsion of steamships, and will be realised when systematic model experiments have been carried out by a competent staff, working on lines which have been laid down in conference with practising naval architects and marine engineers.

Herr Wellenkamp proposed recently[1] a method of experimental research on fluid resistance and ship-propulsion which would involve much less expenditure on experimental establishments and their equipment than is needed for tanks on the Froude system. In principle the method is identical with that adopted by Beaufoy in experiments made in this country for the Society for the Improvement of Naval Architecture towards the end of the eighteenth century. The motion of the model through the water is produced by a falling weight. Herr Wellenkamp was not acquainted with Beaufoy's experiments when he devised his apparatus, nor was he aware that other experimentalists—including the Hon. Charles Parsons—had used similar arrangements in recent years. He has worked out the idea in a most ingenious and thorough manner, and used a large tuning-fork as the time recorder, which marks on the revolving sur-

[1] In a paper read at the meetings of the Institution of Naval Architects in April last.

face of a drum intervals of one-hundredth part of a second. He claims to obtain almost absolute uniformity of motion for a sufficient length of run, and accurate records of the corresponding tractive force and velocity of advance during the part of the run when uniform motion occurs. The system is said to have been adopted by the German Admiralty, and in some of the technical institutions of Germany. Its operation and results will be watched with interest; but in the opinion of the writer the new method is not likely to supplant the Froude system, although it may come into use as a supplementary method of making rapid and fairly accurate "first approximations" to resistance. Even minute errors are magnified so greatly in passing from a model to a full-sized ship or propeller that the nearest possible approach to accuracy in the model experiments must be obtained, and this may justify a continuance of the greater expenditure on the experimental tanks and apparatus involved in the Froude system. Experience will decide this matter, and an extended comparison of results obtained on the old system and the new with models of identical form should afford conclusive evidence as to the best course to be followed in future. Experiment alone can be trusted, as no theoretical investigation or mathematical formulæ can deal adequately with the complex conditions of ship-propulsion.

Scientific analysis of the results obtained from systematic series of experiments on the forms of ships and propellers will certainly exercise great influence, and enable designers to proceed with greater certainty in future. There are already many examples of what may be hoped for ultimately in the published papers of Mr. R. E. Froude, Mr. Taylor and others. At present the volume of such information is insufficient, and many departments of knowledge remain obscure. As to methods of analysis, little can or need be said at present; when materials are available suitable methods will be devised. An interesting attempt to deal with the matter in the light of present knowledge will be found in a paper read before the Institution of Naval Architects by Captain Hovgaard, now professor of naval architecture in the Massachusetts Institute of Technology, and responsible for the training of the naval constructors of the United States Navy. Like Mr. Taylor, Captain Hovgaard owes his professional training to the Royal Naval College, Greenwich, and does honour to that institution. His "Analysis of the Resistance of Ships" is worthy of close study, and is based on wide knowledge of the subject. But his conclusion will commend itself to every student. "Not until tanks are established for research work . . . . will questions like the present one and many others equally important find their solution." Much may be looked for from the tank at Bushy which Mr. Yarrow has offered to establish, provided shipbuilders, marine engineers and shipowners will guarantee the cost of its maintenance. Such an offer cannot fail to be accepted, and the sooner the work of constructing the tank is begun the better will it be for British shipping.

W. H. WHITE.

## LECTURES ON EVOLUTION.

*Vorlesungen über Deszendenztheorien mit besonderer Berücksichtigung der botanischen Seite der Frage.* By Prof. J. P. Lotsy. Pp. vi+381–799. Theil ii. (Jena: Gustav Fischer, 1908.) Price 12 marks.

THE second part of Prof. Lotsy's book contains the substance of twenty-eight lectures, completing his course on evolution. Though making no claim to have broken new ground, the work is of real use. The presentation of contemporary knowledge of these subjects which it gives is comprehensive in scope and accurate in treatment. The author does not suffer from the delusion that in evolutionary science finality was reached fifty years ago, and it is a pleasure to see the results of modern research incorporated without ludicrous mistakes. This is probably the best text-book of the subject yet compiled.

There are occasional signs of vacillation between the old and the new conceptions. For example, as an instance of a dissimilarity between reciprocal crosses, Prof. Lotsy brings forward *Bilbergia nutans* × *vittata* on evidence which would have satisfied the older observers. Knowing the sources of ambiguity which affect such evidence, he remarks that possibly the dissimilarity may nevertheless be due merely to "Pleiotypie in $F_1$." Rather, until it shall have been ascertained by repeated experiment that there is consistent dissimilarity between the reciprocals, the presumption is strong that the differences observed are an expression of heterogeneity in the cross-bred generation as such, and are not dependent on the parental *rôles* allotted to the respective species. The break with tradition which Mendelian discovery has made is, indeed, so wide that a generation must pass before the older interpretations disappear, and evolutionists come to think easily and habitually in terms of the new system. This book will do a good deal towards accelerating the change.

To professed students of genetics this text-book may be recommended as bringing a quantity of fresh materials under consideration which have not previously been dealt with in a consecutive treatise. Of these materials some are ancient and some modern. For the first time, probably, Gärtner's work is presented in summary, and though, judged by modern standards, his experiments are fragmentary and imperfect, many readers will thus become aware of the range of observation which they covered. In another useful chapter a clear abstract of Nägeli's views is provided. Prominence is given to the remarkable experiments of Klebs on *Sempervivum Funkii* showing the influence of external conditions. Facts of this class are extraordinarily difficult to interpret, and until exhaustive work has been done on the same lines we must perhaps abstain from confident interpretation altogether. As a subject for genetic research the Sempervivums are most attractive. To turn over Jordan's plates of this polymorphic genus in the "Conspectus"—still more to see his actual collection of living plants now preserved in Miss Willmott's garden—is to realise the great possibilities which the material provides. It is to be hoped that someone will devote himself in good earnest to an analysis of those protean forms

The book suffers from want of compression, and there are some repetitions. The long chapters on the geographical aspects of the problem serve rather to show how little help must be expected from that line of inquiry until much more minute treatment can be applied. No one supposes that any fresh lesson of importance is to be derived from the broad facts of geographical distribution, and the deductions that have been already drawn could, in so far as they are of consequence, be amply stated in half a dozen pages. On the other hand, as to the more interesting phenomena of geographical inter-relationship, the problems, for instance, of intergrading species, too little is said. In a text-book of this scope it would have been well to direct the attention of students to the necessity for thorough study of facts of this class, a field in which there is room for much analytical research.

There is one rather serious omission. The phenomena of regeneration and the mechanics of development are among the most obscure with which a theory of descent has to cope. In the minds of many evolutionists, the existence of those strange and specific powers of response to injury which modern research has revealed constitutes a formidable problem, and though for its solution we still wait, the facts should have been stated.

In dealing with matters of opinion, Prof. Lotsy shows good judgment and critical power. This is especially manifested in his discussion of adaptation, of the evidence for mutation, and of the assertions by which an attempt has been made to revive Lamarckian views. Sometimes, perhaps, one is conscious of an exaggerated patience. Conventional arguments which the author plainly recognises as bad are repeated out of deference to their originators. The expert is not in doubt as to his real opinion, but the lay reader will carry away the impression that decided questions are still open. When he deals with the writings of Wallace, indeed, he allows himself the remark that this is "*Selectionstheorie à outrance*," but such freedom of expression is rare.

The author gives a full but somewhat non-committal account of the views of Eimer, and discusses the relation of Nägeli to the conception of orthogenesis as a main factor in evolution. Yet, after reading all that is said on this question, it is not easy to seize the exact point which is relied on as a proof of the reality of orthogenesis. The adaptation may be very perfect, and selection of indeterminate variations an unpromising account of the origin of that perfection, but it will never do to attribute this wonderful power of orthogenetic variation to organisms simply because we do not see how they could have become what they are without it. This, apparently, is Prof. Lotsy's view also, but many would have been glad of a more definite lead.

If the book reaches a second edition, as it probably will, the question of reducing it to two-thirds its present size should be considered. In that event also the proofs should be submitted to a professional proofreader, for in this second part, as in the first, the abundance of typographical slips exceeds all reasonable limits.

W. BATESON.

## METALLOGRAPHY.

*Introduction to Metallography.* By Dr. Paul Goerens. Translated by Fred Ibbotson. Pp. x+214; illustrated. (London: Longmans, Green and Co., 1908.) Price 7s. 6d. net.

ALTHOUGH metallography is a very young science, a number of little books on it have already made their appearance, and of these Dr. Goerens's "Einfuhrung in die Metallographie" is not the least successful. The author says in his preface that before the publication of his work the numerous papers on the subject had not undergone systematic collection in Germany. If it is not the only book in this country, it is nevertheless welcome, and Mr. Ibbotson's excellent translation greatly increases its usefulness.

Alloys can be studied in several ways, of which the most important have been found to be the preparation of their cooling curves and the examination of polished and etched specimens under the microscope. The whole book is devoted to these two methods, and no reference is made to the electric and heat conductivity of metals and alloys, to their density, hardness, malleability, ductility, colour, resistance to shock, &c. No doubt this is due to the small amount of systematic investigation that has been devoted to these properties, but when a complete work on metallography is written these points cannot be entirely ignored.

However, the preparation of cooling curves by the use of thermocouples is adequately described by the author, and the various means of detecting critical points explained clearly. There is not much discussion of pyrometers, and the platinum resistance pyrometer, with which Heycock and Neville did their classical work, is not mentioned, presumably because it is not much used in Germany.

Physical mixtures, or bodies of perfectly uniform composition not governed by the laws of valency, are divided by Dr. Goerens into aqueous solutions, fused salts and alloys. He defends this use of the historical method on account of its expediency, observing that the reader will find out for himself as he proceeds that the division is arbitrary. The author, however, soon reaches the alloys, and thereafter for seventy-five pages gives a valuable account of the existing views on their constitution. This part is illustrated by descriptions of a number of series of binary alloys drawn from work on cooling curves done in England, Germany, and France, and the references are numerous and accurate. So many examples are given in each subdivision that it is a pity that here at least completeness was not attempted by including all the binary alloys which have been worked out. The additional space required in a second edition would not be great, and the author would produce a book of reference without destroying its usefulness as an introductory volume for students. There seems no reason to exclude even the mixtures of metals with oxygen, sulphur, arsenic, &c., many of which have been studied by Friedrich. These series of bodies are of higher importance to smelters than the alloys proper, and have been shown to obey the same laws when they are fused and allowed to cool.

The remainder of the book is devoted to the practical microscopy of metals and to an excellent and sufficiently full description of the iron-carbon alloys. The section is entitled "The Special Metallography of Iron and its Alloys," but no mention is made of any alloy of iron except those with carbon, so that for information as to all the special steels, which are now of so much interest, the reader must wait for another edition or another book.

Enough has been said to show that the standard work on metallography is yet to be written, but that students will find Dr. Goerens's book admirable as affording them a glimpse of the methods of investigating metals and alloys.

T. K. R.

## *ELECTRO-THERAPEUTICS.*

*Röntgen Rays and Electro-therapeutics, with Chapters on Radium and Phototherapy.* By Dr. M. K. Kassabian. Lippincott's New Medical Series. Pp. 545. (Philadelphia and London: J. B. Lippincott Co., n.d.) Price 15s. net.

WITHIN the last ten years the study of electro-therapeutics has rapidly grown, and, indeed, the progress has been so great that it is almost impossible for any author to record the constant advances published from day to day. Many valuable and important works have been published upon this subject, and when stating this, Dr. Kassabian says he wishes to present to his readers, clearly and concisely, the more important facts pertaining to electro-therapeutics and Röntgen rays.

The book begins with a general introduction, and considers the use of electricity in the medical curriculum. The following chapters are devoted to the nature and properties of magnetism and electricity, to different methods of producing electrical energy, and it should be said the apparatus required for the different forms have been very fully entered into. The next part of the work is devoted to pathological conditions in general diseases and special departments.

High frequency and, above all, as the title indicates, Röntgen rays occupy a very large part of the book, and the technique has been very carefully gone into. Though treating of this subject generally, the application of X-rays for diagnosis and treatment is fully described, and three chapters are devoted to the study of radium and phototherapy.

It will be seen from the very large number of subjects introduced that it must be a very difficult thing for any author to do justice to all in one volume. It can be said, however, that any student of electro-therapeutics carefully reading this book will find in it a valuable aid, and any practitioner desirous of obtaining an excellent general view of the subject will do well to obtain a copy. There can be no doubt whatever that the scope of the work has been carefully thought out, the descriptions and instructions are clear and concise, and Dr. Kassabian deserves to be congratulated heartily upon the general result. In addition to the printed matter, there are no fewer than 245 illustrations, many of them of great value, and all of considerable service to the student.

We have hinted in the above statement that the subject is so vast that it is difficult to do justice to every department, and the author seems to be conscious of this, because he admits that the space is all too brief for the study of phototherapy. The same might be said of the attention paid to the physiological effects of high-frequency currents. All the same, Dr. Kassabian has exercised a wise discretion, because in some parts of the book, such as the dosage of X-rays—a vexed question, and yet one of vital importance to the profession—he has given an excellent *résumé* of what has been done.

Now and again the author might confuse a beginner for want of a slight explanation; for example, at one time he points out (p. 448) that the X-rays may produce pigmentation of the skin, and, again, he quotes the case of a brunette losing pigmentation by the same agent.

The index, although excellent, might be improved. For example, "hypertrichosis" and "naevus" will not be found under the initial letter of each word, but under "X-rays" in these affections. Other examples might be quoted.

## *OUR BOOK SHELF.*

*On the Plantation, Cultivation and Curing of Parà India-rubber (Hevea brasiliensis), with an Account of its Introduction from the West to the Eastern Tropics.* By H. A. Wickham. Pp. iv+78. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1908.) Price 3s. 6d. net.

MR. H. A. WICKHAM re-tells the interesting story of the successful effort of the Government of India with the aid of the Royal Gardens, Kew, to introduce the Parà rubber tree (*Hevea brasiliensis*) from Brazil to the eastern tropics. Though the tale, at least in outline, is fairly familiar, it is one that bears repeating, and as told by Mr. Wickham will, in spite of a certain ruggedness of style, be read with interest, since it has the advantage of being from the pen of one who can say with truth of the history he relates, *pars magna fui*.

The passages in which Mr. Wickham strives to impress on his readers his experience that the Parà rubber tree is properly a denizen of the immense forest-clad plains which occupy the areas between the great rivers of the Amazon system will attract attention. These plains are considerably more elevated than the flat ground which skirts the banks of the actual rivers, and is periodically inundated when the rivers rise. The tree does, indeed, occur on these low-lying tracts, but in Mr. Wickham's experience it does not thrive so well on these flooded levels as on the somewhat higher plateaux that abut upon them. The question is of interest because of the practical bearing it may have on the treatment of *Hevea brasiliensis* as a cultivated tree.

The discussion of the methods that, in the opinion of Mr. Wickham, are most suitable for the cultivation of the tree and the treatment of its latex will also be read with interest by those engaged in both occupations. The literature of the subject is already extensive, and much of it is of high quality. But what Mr. Wickham has to say will receive the attention of those practically interested in Hevea as coming from one who has had a long working experience of the problems involved, and one who possesses, what is quite unusual, an intimate acquaintance with the Parà rubber tree, both as a forest species and under cultivated conditions.

*Decoration of Metal, Wood, Glass, &c.* Edited by H. C. Standage. Pp. 228. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd., 1908.) Price 8s. 6d. net.

THIS is described as a book for manufacturers, mechanics, painters, decorators, and all workmen in the fancy trades. It consists of a collection of recipes, such as are found in the well-known works of Spon and Cooley, but selected for use in the decorative treatment of various materials.

In the early sections the bronzing of iron, tin, zinc, alabaster, plaster of Paris, paper, and feathers is dealt with. Afterwards follow directions for such miscellaneous processes as the platinising of metals; plating with aluminium; the colouring of metals by immersion in chemicals; silvering and gilding; tinning and galvanising; the use of enamels and glazes; etching; varnishing, lacquering, and japanning. So far as can be judged from a recipe here and there, the methods seem to be trustworthy.

The book has no pretensions to being scientific, and it is necessarily, perhaps, more or less of a medley. Even so, the editing leaves something to be desired. The matter could have been better arranged and coordinated. Careless wording occasionally makes the meaning obscure or misleading. Thus the ingredients of a platinising solution (p. 25) include both ¾ oz. of "ammonia chloride" and 3 oz. of "sal-ammoniac"; whilst no quantity is specified for the chief ingredient, platinum chloride. A chemist would readily see where the blunder lies; a "workman in the fancy trades" would probably be using "langwidge" long before he had found the proper correction. C. S.

*Cast-Iron House Drainage, with Especial Reference to Town Houses.* By G. J. G. Jensen. Pp. xii+206. (London: The Sanitary Publishing Co., Ltd., 1908.) Price 4s. 6d. net.

THE view is gaining ground in this country that it is often desirable to provide cast-iron drainage in lieu of the usual provision of stoneware pipes. The vibration from heavy motor traffic, underground railways, &c., is a circumstance which specially calls for this provision; and it is also possible to lay iron pipes and to join them in circumstances which involve delay and difficulty in the case of cement joints—such as during times of frost and in water-logged ground. The expense involved in repairs of stoneware drains must often exceed the initial increased cost (10 to 30 per cent.) involved in iron drainage, for the cast-iron drain, as the writer points out, is far more durable than the stoneware. This greater durability is mainly due to the longer lengths in which the iron pipes are manufactured, involving a very great reduction in the number of joints; a stoneware drain, for instance, thirty yards in length, will necessitate 45 joints, whereas in a similar length of iron drain there need only be ten. Moreover, the joints being made of molten lead are stronger and more trustworthy than the cement joints of the stoneware drain, and the iron drain is straighter and smoother in the interior. A further advantage possessed by cast-iron over stoneware drainage is the fact that the necessary bends, connections, and provision for inspection can be readily made to suit the special needs of any particular premises.

The advantages of iron drainage have been far more generally recognised in the United States of America than in this country, and the work under review is doing a good service in advocating a wider adoption of the safer method.

The general principles of sanitary drainage construction are also discussed in a very sound and practical manner; and the directions given throughout the book leave nothing to be desired on the score of clearness.

*Macmillan's Orographical Map of Europe.* Designed by B. B. Dickinson and A. W. Andrews. Size, 62×51 inches. (London: Macmillan and Co., Ltd., 1908.) Cloth, mounted on rollers, price 15s.

*Notes on the Orographical Map of Europe.* By the same authors. Pp. 30. Limp cloth, price 1s.

IN this excellent wall map the distribution of lowlands and highlands is shown by six different colours representing land below sea level, and that between the contours 0–600 feet, 600–1500 feet, 1500–3000 feet, 3000–6000 feet, and above 6000 feet. Ocean depths in fathoms are indicated by white and four shades of blue. The only names on the maps are printed very small, and are intended for the use of the teacher exclusively. The position of important towns is indicated by dots. These expedients have made it possible to produce a remarkably clear map on which the physical features of essential importance can be seen easily from every part of a class-room. In these days, when all good geographical teaching is based upon the broad principles of physical geography, an orographical wall map is an absolutely necessary accompaniment to every lesson, and teachers will welcome such a map designed by two competent authorities and produced in the best modern style at a moderate price.

The explanatory handbook provides valuable guidance as to how the map may be used most instructively.

*Familiar Swiss Flowers.* By F. E. Hulme. Pp. viii+224. (London: Cassell and Co., Ltd., 1908.) Price 7s. 6d. net.

THE title of the book makes it evident that it contains a selection of species, and is written for the *dilettante*. As the illustrations are the guiding and principal feature, the former is a necessity, and as to the second observation it is recognised that professed botanists are few, while the number of those sufficiently interested in flowers to learn their names is large. It will also be noted that Mr. Hulme is not treating of Alpine flowers only, although a number of these are naturally included.

The author's talent for depicting flowers is well known from the floral studies reproduced in "Familiar Wild Flowers" and other publications. The plates in the volume under notice bear evidence of his appreciation of the characteristic appearance and identity of the various specimens; the illustrations of the anemones and the white flowers are especially charming. The author has somewhat unnecessarily mingled the figures of plants that bear no relationship to one another, and has taken up valuable space with a few flowers that are too well known to require illustration; but the selection is generally wise, and the inclusion of many lowland plants should meet with approval. Sufficient information is given in the text to determine many species allied to those chosen for illustration.

At the present time of year, when so many tourists are contemplating a holiday in Switzerland, they will assuredly add to their pleasure by taking with them the means of identifying the flowers that appear to have a greater brilliancy in that country owing to their profusion, and this book, prepared with such a purpose, can be safely recommended.

*Astronomischer Jahresbericht.* Vol. ix. Pp. xxxv+653. (Berlin: Georg Reimer, 1908.) Price 21 marks.

We are glad to direct attention to the ninth issue of this very valuable compilation, which is of great utility to all those who study astronomy, and by this time should have found its place in every observatory. The high standard has been thoroughly maintained, and the fact that the present volume is made up of 653 pages gives some idea of the quantity of material which has been dealt with. It may be mentioned, for the information of those who are not familiar with the previous annual volumes, that, in addition to the references to all the more important astronomical publications during the past year, a concise and accurate abstract of each research in question is given in nearly every case.

The importance of having such an abstract is obvious, for it enables the reader to become acquainted at once with the pith of the work described, and saves him probably much time and trouble, if he had had to procure the original work from a library and found that it did not contain the kind of information he was desirous of obtaining. There is no doubt that the compilation of such a volume as this involves strenuous labour on the part of those who bring this information together, and the least astronomers can do is to see that such an undertaking is not brought to an end by inadequate support on their side. W. J. S. L.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

### The Crystallisation of Over-cooled Water.

In order to show the over-cooling of water and to allow the free development of its crystals, I endeavoured to introduce in the over-cooled water a piece of ice put in a finely drawn-out glass tube. The experiment, carried out the first time by Mr. Michael Iwanow, gave an unexpected result; when the crystallisation reached the end of the tube, an ice-crystal having the shape of a hexagonal star, and very similar to the characteristic snow-crystals at this point, began to grow.

Fig. 1.

Fig. 2.

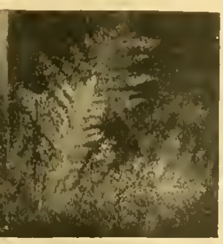


Fig. 3.

The greater the over-cooling of water the greater were the abundance of ramifications and the velocity of crystallisation. With water over-cooled to a temperature between $-0^{\circ}\cdot 3$ and $-1^{\circ}$ I obtained small stars (Fig. 1) with few narrow ramifications. The over-cooling to a temperature between $-1^{\circ}$ and $-3^{\circ}$ gave rise to stars with so densely developed ramifications that they resembled hexagonal plates (Fig. 2). The plane of stars contains the direction of the end of the tube, and therefore when this end is vertical a sufficiently large plate can divide the vessel in two parts. An over-cooling greater than to $-3^{\circ}$—especially when the end of the tube is not narrow enough—produces several plates set in different azimuths, and the whole mass becomes at last a mixture of differently sized crystals and water, resembling the so-called "anchor-ice."

The crystals are often a conglomeration of several stars which have their planes, their principal rays, and even the ramifications of higher order parallel (Fig. 3).

When a star is broken the pieces of it rise horizontally in the water with slight oscillations and attain in such position the surface. This circumstance can explain the verticality of optic axis of river- and lake-ice.

The evolution of these artificial snow-crystals can be easily projected on a screen if the vessel with over-cooled water (a tumbler or an evaporating dish) be put into another vessel with plane-parallel sides containing water of a temperature somewhat higher than the thaw-temperature of the surrounding air. Any water will serve for over-cooling, but the refrigerating mixture (finely chopped ice upon which is poured a strong solution of NaCl) must not be too cold (from $-4^{\circ}$ to $-6^{\circ}$), and its level must be lower than the level of the water which is to be over-cooled.

The projection is especially beautiful when the vessel is placed between two crossed Nicols (the photographs of Figs. 1–3 are taken in this way); on a dark ground grows a star, which gradually becomes more and more white, and at last—when thick enough (the thickness is generally of the order of a tenth of a millimetre)—obtains the colours of chromatic polarisation. It is easy to prove that these crystals are optically uniaxial, the tube being turned so long that the plane of a star is at right angles to the rays of polarised light, the image of the star disappears.

Precise measurements of these crystals are to be made in winter, when it will be possible to prolong their fugitive existence. The size of the stars depends—at a sufficient over-cooling, *e.g.* of $-2^{\circ}$—principally on the dimensions of the vessel with over-cooled water; I often obtained single stars 8 cm. to 12 cm. broad. Boris Weinberg.

St. Petersburg, July.

### Bright Meteors on August 19.

On August 19 there was an unusual display of three bright meteors within about five minutes. The details were recorded here as under:—

| h. m. | | ° | ° ° | sec. | Radiant |
|---|---|---|---|---|---|
| 9 40 | >1 | ... 220+66 | ... 202+62 | ... 1·8 | ... 288+59 |
| 9 44 | 1 | ... 355+79½ | ... 283+70 | ... 1·0 | ... 56+60 |
| 9 45 | | ... 269+ 9½ | ... 256+15½ | ... 2·0 | ... 320−15 |

The first was one of the *o* Draconids, the second a belated Perseid, the third a δ Capricornid. The Perseid was well observed, and it would be interesting to obtain a duplicate record of it. W. F. Denning.

Bristol, August 20.

### Barisal Guns in Western Australia.

I have just received the following note from Mr. H. L. Richardson, Hillsprings Station, 100 miles north-east of Carnarvon, on our west coast:—

"A peculiar incident happened here last evening (June 26) about an hour after sunset. In a south-easterly direction from here three reports took place high up in the air, and then a rushing noise like steam escaping, lasting for a few seconds, and gradually dying away. Mr. Loeffler, one of the owners of this station, was standing outside with me at the time. It was a beautifully clear evening, and there was nothing visible at all in that direction. The reports sounded like explosions of some combustible to which there was no resistance." W. E. Cooke.

Perth Observatory, Western Australia, July 20.

## SURVEYING FOR ARCHÆOLOGISTS.

### I.

We have now two societies for the astronomical study of ancient monuments at work in Britain; a considerable number of the monuments have already been astronomically surveyed, with the result that the various alignments indicated have been shown to have been laid out to facilitate and utilise observations of the sun or stars.

It is not to be wondered at, therefore, that I have been repeatedly asked, now in one region, now in another, to put on paper some general hints to those who may feel inclined to take up the work so as to secure the necessary observations.

I think the first useful thing to say is that the inquiry is much less complex, and takes much less time in the measurement of any one monument, than is generally imagined; that the ideas involved are very simple, and do not go beyond the knowledge which should be possessed by everybody who wishes to enjoy and understand something of the world around him.

In the first place, the astronomical side of the inquiry, so far as the monuments are concerned, is very restricted. It has little to do with the various data concerning them which archæologists, with wonderful diligence, have now been accumulating for several centuries. The weight, shapes, size, colour and nature of the stones are not in question. All use of the spade for finding treasure or anything else is not in our province. If, when plans are given, the relation of the stones to each other is accurately given, we can accept them so far as the arrangement of the stones *inter se* is concerned.

One great advantage of being freed from the necessity of doing all this work is that would-be inquirers are saved the expenditure of a great deal of time and money; to them the spade is needless, because they deal only with the relation of the monument to the surrounding surface, and for the same reason the conditions of the stones themselves are indifferent to them.

What, then, is it they have to do? They have simply to determine, with an accuracy as great as can be achieved by the instruments at their disposal, the line of direction indicated by the lie of the stones in the various monuments. This problem is at its simplest in the case of the so-called "Avenues," such as those at Challacombe and Merrivale, on Dartmoor.

Do they lie east and west, or north and south, or in any other intermediate direction?

Again, take the cases of the so-called "outstanding" stones or tumuli so often met with at some distance outside the Cornish circles—those of the Merry Maidens and Tregaseal, to give instances; do they lie to the east, or the west, or the north or the south, or at some intermediate angle? and at what angle?

In the case of cromlechs or dolmens the matter is not quite so simple, except in the case of those furnished with an obvious outlook, an *allée ouverte* or *couverte*, to adopt the terms employed by French archæologists. I suppose there are hundreds of monuments of this class, of which so-called "plans" exist, but in spite of these plans, which may be quite good so far as the interrelation of the stones is concerned, we have no certain knowledge as to the exact direction in which these alley-ways or creeps point. The stones have been dealt with as stones, and their relations to their surroundings have been entirely neglected.

Fundamentally, then, to get out of this *impasse* it is a question of these directions in the first instance.

How is this to be done? It is here that the elements of knowledge of the things around us, which, I am thankful to say, now form part of the teaching in our best elementary schools, and which, therefore, are not of a very recondite nature, come in.

The ancient monuments, like everything else on the face of the earth or sea, appear to anyone who examines them close at hand to occupy the centre of a plane, which is really the little bit of the surface of the earth that we can see from any one point of view. This circular patch of land or sea is bounded in every direction by what is called the *horizon*, which is the most distant part of the land or sea from us, and on which the sky seems to rest. In the case of the sea, this horizon is level all round. In the case of the land, it may be high or low according to the surrounding conditions. If we live in a street it is high, its height depending upon the number of storeys in the opposite houses; if we are on the heights of Dartmoor it is very low, almost as low as a sea horizon, and as sensibly circular.

Suppose us, then, surrounded by this circular horizon, in front of an avenue; how, when we have measured the stones and plotted them at the proper distances apart, can we indicate the general direction of the lines of stones? We can divide the circle of the horizon, like all other circles, into 360°. But where—in what direction—are we to begin the numbering? Where must the zero be?

All mankind has now agreed for hundreds of years that the zero must be the *north* point; opposite to it is the *south* point, and the line joining these north and south points is called a *meridian line*.

This meridian line, passing along the earth's surface and joining the north and south points of the horizon, lies in a vertical plane passing through the point overhead called the *zenith*. The term meridian is used because the sun passes through this plane at the middle of each day. The line at right angles to the meridian line passes through two points on the horizon midway between north and south. These are called the east and west points, and in the four points now named we have the so-called *cardinal* points on the horizon.

The meridian so defined is called the *astronomical meridian*, and the cardinal points of the horizon involved are called astronomical or true.

The *astronomical* north and all the other points are absolutely stable; they never vary, and are always the same at all places. This north point may be roughly found at night, as it is the point of the horizon under the pole-star, the star which nearly occupies the centre of the circle round which the stars revolve in their daily apparent movement. The south point may be defined as the point of the horizon under the sun at noon.

Now all this seems plain sailing, but the trouble of it is that there are two north points and two meridians to be considered.

If we take a magnetic needle and balance it horizontally on a vertical pivot, its ends will be directed to two points on the horizon, which are not the same at all places with regard to the cardinal points. By drawing a great circle through these two points and the zenith point of the place, we obtain the plane of the *magnetic meridian*. The magnetic needle, as we see it in a pocket compass, has a marked N. end, and its length lies in and defines the magnetic meridian.

The *magnetic meridian line* is the intersection of the plane of the magnetic meridian with the plane of the horizon.

In Britain these two meridians do not coincide; at present, on the average, they form an angle with each other of some 18°. So that the magnetic north is 18° to the west of the true north.

The angle between the astronomical and magnetic meridian lines is called the magnetic *variation*, east or west according as the north end of the needle points to the west or east of true—that is, astronomical—north at any particular place at any particular time.

Such a needle is never at rest, as it is for ever under the influence of the magnetism of the earth, which is always varying. The north point it indicates, therefore, *varies* from year to year; hence the term *variation*; it also greatly varies from place to place, so that there is nothing stable about it; another difficulty is that there may be a local magnetic attraction, caused by iron in the underlying strata, or even gas or water pipes or iron railings, which interferes with the general magnetic attraction at the place, so that a reference to a *general* chart is insufficient.

In a survey of any kind, whether of stone monuments or houses and trees on an estate, to take instances, the first desideratum is a point of reference to which all measures must be referred; but the plan as a plan is incomplete unless the relation of the point of reference used to the astronomical north, or the magnetic north, point of the horizon is quite accurately shown.

Now, the reason that so many archæologists have dealt with the magnetic meridian and the magnetic north is that it is much more easy to determine it. Unfortunately, it has not struck them that their measures of angles, *so far as direction is concerned*, are useless unless the relation of the magnetic meridian to the astronomical meridian, at the monument under investigation and at the time of measurement, has been accurately determined.

It must be confessed that there is much excuse for them, for, until a few years ago, it was difficult in the absence of magnetic surveys to obtain this relation, which consists in an accurate statement of the angle called, as we have seen, the *variation* between the magnetic and astronomical meridians, or, in other words, the angle between the magnetic and astronomical north points of the horizon.

To give a concrete case of the facts, let us consider the case of the Nile Valley, where work such as we are now considering was begun by a Commission of the French Academy of Sciences in 1798.

They found that in 1798 a magnet swung along a line extending from a little to the west of Cairo to the second cataract had a variation of $11\frac{1}{2}°$ to the west. In 1844, when the great Lepsius, the prince of archæological surveyors, arrived on the scene to prepare his majestic plans of the temples, he found the west variation no longer $11\frac{1}{2}°$, but $8\frac{1}{2}°$. At the present time the variation is nearer 4° west. But, alas! in the modern British Schools and Institutes of archæology little attention is given, to judge from the data shown in the plans they publish, to the question which we are now considering. A notable proof of this may be gathered from the fact that, in spite of all the statements and plans that have been made lately concerning the newly explored temple at Deir-el-Bahari, I have been unable to learn whether the indicated direction of the axis of the temple is magnetic or true; the only information given me, oh! shade of Lepsius! is that the variation had not been determined by the surveyors.

It will be gathered from the above that when we may have to deal with such a large change of the variation in a century, an old plan with magnetic bearings but without the date of the actual observations is worse than useless. Even when the date is given, a reference to old Admiralty charts is necessary to get even an approximation to the value of the variation. This is one objection to the use of the magnetic meridian.

But, whatever has happened in the past, for the future British archæologists can hardly be excused from neglecting to compare the magnetic meridian they may use for their plotting with the true or astronomical meridian, and stating it on their plans.

Both the Admiralty and the Ordnance Survey have lately been busily employed in determining the magnetic variation over the British Isles, and in future it will be shown on every 1-inch Ordnance map, so that every archæologist, for the expenditure of one shilling, will be able to learn the present variation at any monument he may chance to be surveying. Indeed, it may be said that some of the old difficulties are now in a large measure solved.

The Admiralty have recently prepared a map showing this variation for the British Isles for last year, from which archæologists can learn approximately the value of the variation, and hence the direction of the true north, at any place.

But because most of the difficulties connected with the observations of magnetic bearings are disappearing, it is certain that the magnetic method will still continue to be largely employed, as it is the easier to work with.

It is not too early to emphasise the important fact that for the *astronomical* study of the various directions we want, for a reason I shall state later on, more than the angle from the north point, either magnetic or astronomical, generally termed the *azimuth*. We want the angular height of the horizon where the line of direction cuts it. This is called the *altitude*.

### HOW AZIMUTH AND ALTITUDE ARE DEFINED AND READ.

#### *Azimuths.*

*The Point Method.*—A reference to the transactions of antiquarian societies will show that in the past the most commonly employed method of stating direction, or azimuth, has been by using a compass needle armed with a card such as is used by mariners, and hence called a mariner's compass. This, of course, gives us magnetic bearings.

In this the circle is divided into thirty-two parts, called points: four chief magnetic points, N., S., E., W.; four quadrantal points, N.E., S.E., S.W., and N.W.; and twenty-four intermediate points. If we take the N.E. quadrant, for example, the eight defining points are N., N. by E., N.N.E., N.E. by N., N.E., N.E. by E., E.N.E., E. by N. Now as these thirty-two points cover the 360° in the complete circle, each point contains 11° 15′, so that, reckoning directions in this way, there is a play of more than 10° for each statement made.

But the objection to this method of defining does not end here. If we read the bare statement that a cromlech, to take an instance, is open, say, to the N.E., one is apt to think that the true N.E. is intended; but where the variation is about 22°, as it is now in the west of Ireland, true N.E. is N.N.E. by compass, that is, two points more westerly.

This system of reckoning, then, besides being misleading, is too coarse for our purpose, so much so that even mariners are now giving it up, using degrees instead of points.

*The Degree Method.*—In the compass card so divided into degrees instead of points we may have 0 at both the N. and S. points (mag.), reading to 90° at the E. and W. points (mag.), or to 180° at the opposite point. Or, again, we may have 0° at the N. point (mag.), reading through the E., S., and W. points to 360°. Each mag. bearing is now defined quite independently of any quadrant, so mag. east would read N. 90° E., and mag. west N. 270° E.

The circles of small instruments are graduated to degrees, and so the azimuths are read to degrees and estimated to half degrees. In instruments with larger circles, whether it be a circular protractor for reading azimuths on maps, or a theodolite for determining them, the degree can be read to $\frac{1}{10}$th of a degree, or even more finely, by means of a device called a vernier, on which it is useful to dwell a little, as many regard it as of a recondite and mysterious nature and avoid it accordingly, whereas it is as simple as it is useful.

The vernier is a short scale, constructed so that its divisions are smaller by a definite and convenient amount than those of the scale with which it is used. In a very simple case this difference amounts to $\frac{1}{10}$th of a scale division, and the vernier is made so that its ten divisions are equal in length to nine of the primary scale. One extremity of the vernier scale is the reference point, or zero, and if this be coincident with a scale division, the remaining divisions of the vernier will be separated from divisions of the scale as indicated below :—

| | | | | | |
|---|---|---|---|---|---|
| Division | 0 | of vernier | coincident with division of scale. | | |
| ,, | 1 | ,, | falls $\frac{1}{10}$th short of division of scale. | | |
| ,, | 2 | ,, | ,, $\frac{2}{10}$ths | ,, | ,, |
| ,, | 3 | ,, | ,, $\frac{3}{10}$ths | ,, | ,, |
| ,, | 4 | ,, | ,, $\frac{4}{10}$ths | ,, | ,, |
| ,, | 5 | ,, | ,, $\frac{5}{10}$ths | ,, | ,, |
| ,, | 6 | ,, | ,, $\frac{6}{10}$ths | ,, | ,, |
| ,, | 7 | ,, | ,, $\frac{7}{10}$ths | ,, | ,, |
| ,, | 8 | ,, | ,, $\frac{8}{10}$ths | ,, | ,, |
| ,, | 9 | ,, | ,, $\frac{9}{10}$ths | ,, | ,, |
| ,, | 10 | ,, | is coincident with | | ,, |

If then the vernier be in such a position in relation to the scale that its fourth division is coincident with

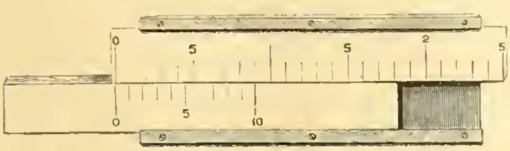



FIG. 1.—Model of a vernier showing how the divisions on a straight line can be divided into tenths. Here the vernier (below) has its zero point coincident with a division on the scale.

a scale division, the zero mark must be $\frac{4}{10}$ths removed from a scale division, and so on. In this way the coincidence of the vernier and scale divisions indicates the fractional part to be read.

It is quite easy to make a wooden model of a fixed scale and a sliding vernier; a little manipulation of this will make everything quite clear.

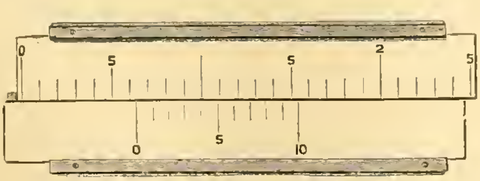



FIG. 2.—Here the zero of the vernier is between the 6th and 7th divisions of the scale. The third division of the vernier is coincident with a division of the line, so the reading is $6\frac{3}{10}$.

In a circle graduated to half degrees, the vernier is so constructed that its thirty divisions are equal in length to 29 divisions of the circle. The vernier divisions are therefore smaller than those of the circle by

$$\frac{1}{30} \times 30' = 1'$$

and the vernier is said to read to one minute. Thus to set the index of the vernier at the reading 30° 18′, first adjust it to the position 30°; then move the index towards the mark corresponding to 31°, and stop when the eighteenth division of the vernier becomes coincident with a division of the scale.

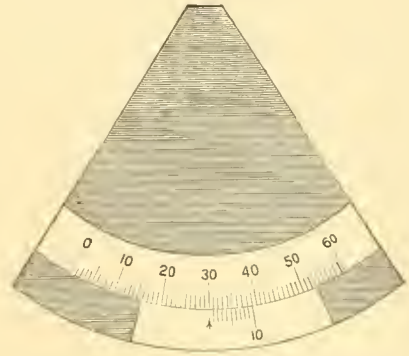



FIG. 3.—A vernier applied to a circle enabling azimuths (or any other angle) to be read to tenths of a degree.

So much, then, for the reckoning and readings of azimuth, measurements on a horizontal plane.

### *Altitudes.*

For the reckoning of altitudes, which of course are observed with a vertical circle, the degree system is alone used, the fineness of the reading depending upon the size and graduation of the circle employed. The vertical circle is generally graduated into four quadrants of 90°, the zeros lying in the horizontal line. We can thus read elevations or depressions in degrees, or some smaller division of a degree.

NORMAN LOCKYER.

## *THE PERCY SLADEN TRUST EXPEDITION TO MELANESIA.*

IN the autumn of last year the trustees of the Percy Sladen Memorial Fund made a grant to Dr. W. H. R. Rivers, F.R.S., of St. John's College, Cambridge, to enable him to make detailed sociological studies in the Pacific, and more particularly to study mother-right communities in the Solomon Islands, and to trace the details of the transition from mother-right to father-right. Dr. Rivers left England at the end of November, and, after staying a short time in the United States, proceeded to the Hawaiian Islands. Dr. Lewis H. Morgan, in his classical work, "Ancient Society," says (p. 403), "Among the Hawaiians and other Polynesian tribes there still exists in daily use a system of consanguinity which may be pronounced the oldest known among mankind. . . . It is the simplest, and therefore the oldest form, of the classificatory system."

The investigations of Dr. Rivers into the kinship systems of the two groups of Torres Straits islanders (Reports Camb. Exped. to Torres Straits, vols. v., vi.), and subsequent comparative studies led him to the conclusion that "as the Polynesian languages have arisen by simplification of those of the Melanesian family, so have the Polynesian kinship systems arisen by simplification of a variety resembling those found among Papuan and Melanesian peoples at the present time" (Rivers, "Anthropological Essays presented to E. B. Tylor," 1907, p. 314). In an essay (based on information obtained from natives by means of the genealogical method) which he has sent home, Dr. Rivers proves that his hypothesis was justified. He says, "The Hawaiians have lost nearly the whole of their old culture, and present from the point of view of the anthropologist a most depressing picture of the results of a century of contact with civilisation, and yet in the midst of the general wreckage there has persisted almost untouched the old system of kinship, which, so far as we can tell, is as it was fifty or a hundred years ago." The Niue (Savage I.) system was found to resemble closely that of the Hawaiian Islands. A short visit to Nukualofa enabled Dr. Rivers to record the Tongan system of kinship, which proved to be the representative of a stage in the process of transition in which certain distinctions, lost elsewhere in Polynesia, have been preserved. The Samoan kinship system proved to be anomalous, and falls much less into line with our knowledge of the mode of expressing relationships found elsewhere in Polynesia. The "godless Samoans," it will be remembered, differed in other respects from typical Polynesians; their Government was more patriarchal and democratic than monarchical; the village communities were quite independent and could dispossess their chiefs; there were no temples, altars, or offerings; there was a family cult of the animal god; in addition each individual has his tutelary god, as had the village.

Dr. Rivers spent nearly a month in Fiji, most of which time was devoted to the interior of Viti Levu; there he found an entirely new system of kinship of the most complicated and interesting kind, and quite different from the system previously recorded as the Fijian system; the latter is in vogue in the district dominated by Bau, though, so far as he could ascertain, it, with many minor modifications, is used by coast people generally. He elucidated the systems of some ten different tribes, showing variations of the two Fijian systems. It is rather surprising that such very considerable variations may exist in the kinship systems of people living close to one another, and differing in no way in general racial characters. Dr. Rivers is of opinion that the relationship terms of the mountain tribes must have had their origin in status relations rather than in those of kinship, and he suggests a comparison with the system of the Dieri of Australia.

Through the kindness of Bishop Wilson, Dr. Rivers was given a passage on the *Southern Cross* of the Melanesian Mission on her rounds from Auckland to the Solomon Islands. This enabled him to interview a large number of natives of various islands. He worked out fairly thoroughly the system of Raga (Arag, or Pentecost), which is by far the most complex one he has ever met or heard of; in fact, all the systems of the southern New Hebrides are so complex that he has come to look on such systems as those of Torres Straits as child's-play. The chief feature of the Raga system is that the same terms are used for certain grandparents and for certain relationships by marriage, while the mother's mother is called by the same name as an elder sister, just as in the inland systems of Fiji the father's father has the same name as the elder brother. A native of another island (who found it very amusing) told Dr. Rivers that the Raga people used to marry their granddaughters, and indeed he found that it used to be the custom in Raga for a man to marry the daughter of his brother's daughter. The Raga system also presents another set of complexities, which it shares with the system of Mota, one which puts the children of brother and sister in the relationship of parent and child. These features are all referable to the principle given by Codrington, which puts the sister's son on the same level as the uncle.

In the Solomon Islands, Dr. Rivers has obtained, so far, seven systems, which are all extremely simple in their general features, and he feels certain that they are really simplified and stand in much the same kind of relation to those further south, as the coast systems of Fiji stand to those of the interior. The three systems of Ngela, Bogotu, and northern Guadalcanar are on the same general lines, and many of the terms are exactly the same, and used in the same way, as those of the Bau system of Fiji. Those of Ulawa and Saa are of the most extraordinary simplicity, almost Polynesian in this respect. The whole set of systems seems to him to furnish beautiful evidence of the progressive simplification of kinship systems which accompanies progress in general culture. In every case Dr. Rivers has obtained a large body of evidence on kinship duties and taboos, &c., or their absence, all showing that the simplification of kinship systems goes with the disappearance of these duties and taboos. He has also obtained abundant evidence to show that the maternal descent in Melanesia does not in any way exclude a very thorough recognition of kinship through the father. All this work has been accomplished by the genealogical method, without which he could have done nothing in the time to which he would have attached any value.

The foregoing account will give an idea of some of the work already accomplished by Dr. Rivers; amongst other important results, not here alluded to, is a description of totemism in Fiji, which will be published in the September number of *Man*. In his last letter from Tulagi, dated May 8, Dr. Rivers was about to settle down in a definite district, probably in Rubiana, where he will make an exhaustive study of the natives, assisted by Dr. A. M. Hocart, of Exeter College, Oxford, and Mr. G. C. Wheeler, Martin White Student of the University of London, who had already joined him.

A. C. HADDON.

## THE PRESERVATION OF WELL-ESTABLISHED NAMES IN ZOOLOGICAL NOMENCLATURE.

AS was announced in NATURE of July 30, a discussion will take place in Section D of the British Association on the abuses resulting from the strict application of the rule of priority in zoological nomenclature and on the means of protecting well-established names.

Much inconvenience is caused by the extreme application of the rule of priority, the worst feature of which is not so much the bestowal of unknown names on well-known creatures as the transfer of names from one to another, as we have seen in the case of Astacus, Torpedo, Holothuria, Simia, Cynocephalus, and many others which must be present to the mind of every systematist. Yet these changes are proposed in order to comply with so-called laws enacted by various committees that have dealt with the subject of nomenclature within the last few years. Many zoologists think it is time to protest against the evil resulting from the indiscriminate application of what would be an excellent rule if tempered by a little consideration for tradition. Botanists at the Vienna Congress of 1905 have considered the same subject as regards the generic names of plants, and decided not to change such as have been universally used.

In anticipation of the discussion that is to take place at Dublin, the following memorandum has been circulated among British zoologists, and the signatures which are appended to it show that strict adherence to the rule of priority is far from meeting with general support, at least in this country.

The undersigned zoologists, whilst fully realising the justice and utility of the rule of priority in the choice of scientific names for animals, as first laid down by a committee of the British Association in 1842, wish to protest against the abuse to which it has been put as a result of the most recent codes of nomenclature, and consider that names which have had currency for a great number of years should, unless preoccupied, be retained in the sense in which they have been universally used. Considering the confusion that must result from the strict application of the rule of priority, they would welcome action leading to the adoption of a scheme by which such names as have received the sanction of general usage, and have been invariably employed by the masters of zoology in the past century, would be scheduled as unremovable.

(*Signed*)

| | |
|---|---|
| E. Ray Lankester. | A. Günther. |
| A. Sedgwick. | J. C. Ewart. |
| P. Chalmers Mitchell. | d'Arcy W. Thompson. |
| Sydney J. Hickson. | Henry Woodward. |
| R. Bowdler Sharpe. | E. A. Minchin. |
| A. E. Shipley. | P. L. Sclater. |
| J. Arthur Thomson. | W. N. Parker. |
| Gilbert C. Bourne. | W. J. Sollas. |
| E. S. Goodrich. | Edward B. Poulton. |
| J. J. Lister. | Chas. O. Waterhouse. |
| W. C. McIntosh. | A. Smith Woodward. |
| F. Jeffrey Bell. | S. F. Harmer. |
| W. T. Calman. | W. Bateson. |
| W. E. Hoyle. | D. Sharp. |
| A. M. Norman. | J. Stanley Gardiner. |
| J. Graham Kerr. | G. A. Boulenger. |

## THE SOUTH AFRICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE visit of the British Association to South Africa in 1905 in many ways undoubtedly represented the high-water mark of scientific effort in the various colonies for some time to come. Three years ago the results of the commercial inflation consequent upon the war were only feebly foreshadowed, and Governments and people still hoped that the depression then beginning to loom would pass away. To-day no reasonable person questions that the colonies will, for a time, have to be run on a lower level, and unfortunately education and scientific endeavour have to be adapted to this standard. As regards association matters, Cape Town apparently exhausted itself in the 1905 effort, but now congratulates itself as the headquarters of the newly chartered Royal Society of South Africa. The Transvaal maintains its vigorous interest in the aims of the association, and has largely contributed to the success of the subsequent meetings, Kimberley in 1906, Natal in 1907, and the Grahamstown gathering just concluded.

The Grahamstown meetings, held at the Rhodes University College, were attended by about seventy visiting members, an encouraging number when one considers distances in South Africa. These, together with about one hundred local members and associates, served to justify fully the continuance of the annual gatherings of the association, and afforded that personal touch with fellow-workers so much needed by the comparatively isolated colonial man of science. The meetings were held under the presidency of Sir Walter Hely-Hutchinson, G.C.M.G., Governor and Commander-in-Chief of Cape Colony, and in his unavoidable absence, owing to Parliament being in session, his place was taken by Prof. S. Schönland, one of the vice-presidents of the association. The Governor's presidential address, which dealt mainly with the progress of scientific research in South Africa, was read by the Hon. Mr. Justice Graham, a grandson of the founder of Grahamstown.

Though Grahamstown was not deemed worthy to receive the British Association in 1905, a function reminiscent of the parent association was the first annual award of the South African medal and grant of 50*l*., raised in commemoration of the visit, "for achievement and promise in scientific research in South Africa." This was presented to Dr. Arnold Theiler, C.M.G., bacteriologist to the Transvaal Department of Agriculture, in recognition of his researches on animal diseases.

The meetings were divided into five sections, as follows:—Section A (mathematics, physics, astronomy, meteorology, and geography); president, Dr. Alex. W. Roberts; address, "Variable Star Research." Comparatively few papers were contributed to this section. Sections B and C (chemistry, metallurgy, geology, engineering, mining); president, Prof. E. H. L. Schwarz; address, "The Geological Discoveries of Economic Importance made by the Albany Pioneers." A dozen papers were offered on geological, mining, and engineering subjects. Section D (botany, zoology, agriculture, forestry, bacteriology, physiology); president, Prof. S. Schönland; address, "Some Aspects of Recent Progress in Pure and Applied Natural Science." This was the strongest section in contributions, the papers being mainly of zoological, botanical, and agricultural interest. Section E (education, psychology, history); president, Mr. E. G. Gane; address, "Tendencies in Modern Education." A special debate on native education took place in this section, the chief points of dispute being whether the native should be educated in the vernacular or the English language, and whether his education should be continued as far as university standards. About fifteen other papers dealt largely with different aspects of education. Section F (economics, archæology, ethnology); president, Mr. W. Hammond Tooke; address, "Notes on the Earlier Contributions to South African Anthropology." A dozen other papers were devoted mainly to anthropological subjects, and a demonstration of the ethnological exhibits in the Albany Museum was included.

The social functions included a reception by the Mayor and Corporation, receptions and entertainments by the various educational organisations of the city, visits to local institutions and places of interest, including a day at Port Alfred, and half a day at an ostrich farm. The evening popular lectures included one by Prof. G. E. Cory, on the history of the Eastern Province, and another by Dr. Theiler, on animal diseases in South Africa.

At the closing meeting of the council it was decided to hold the next (seventh) annual meeting of the association at Bloemfontein, under the presidency of the Governor of the Orange River Colony.

The annual meetings of the South African Ornithologists' Union were held conjointly with the meetings of the association, and were comparatively well attended. The president, Prof. J. E. Duerden, gave an address devoted to his researches upon the domesticated ostrich in South Africa, and several other papers on more orthodox ornithological subjects were contributed. At the business meeting a discussion took place as to the conduct of the Journal of the Union, when it was decided to issue a series of popular bulletins in addition to the Journal, with a view to encourage a wider interest in ornithological matters amongst sportsmen, farmers, and others.

J. E. Duerden.

Subjoined are extracts from the address prepared by Sir Walter Hely-Hutchinson, president of the South African Association:—

A remarkable advance has taken place in South Africa of late years in the matter of general public interest in scientific matters. Scientific men have taken an interest in, and have studied, South Africa for more than 150 years—La Caille, Le Vaillant, Herschel, Burchell, Lichtenstein, Andrew Smith, for example, are names which will be familiar to you, and will always be remembered in connection with early scientific inquiry and development in South Africa. But it is not so many years ago that scientific men were prone to be generally regarded in South Africa as an interesting class of persons who unselfishly devoted their lives to asking questions of nature, and to getting further conundrums for answers—amiable enthusiasts who actually worked, many of them, for nothing, read papers to each other on all sorts of abstruse subjects at the meetings of the Philosophical Society, and no doubt found out a great many interesting things, but were more or less outside the real and practical business of making a living. The general and commonplace view probably was, that when it came to dealing with the problems and difficulties of everyday life, your "practical man" was more likely to be successful, or more useful as an adviser, than the scientific man who was continually betraying an almost indecent curiosity about the secrets of nature, which, in some of its phases, might be regarded by many people as not wholly orthodox or reverent, and devoted his time and his intellect to the solution of questions which did not appear to have any practical bearing on the ordinary problems of life. By degrees, however, the practical value of scientific inquiry, and of scientific knowledge, became more generally apparent. Overlapping boundaries of farms, for instance, and consequent litigation, demonstrated the necessity of a scientific system of survey. Thousands of pounds have since been spent on the triangulation of the Cape Colony, and a secondary triangulation is in progress. The main triangulation has been extended throughout South Africa, and the work has been carried forward through Northern Rhodesia to Tanganyika in the shape of a geodetic survey which will in due course be prolonged to Cairo. With this great work the name of David Gill, the first president of this association, will always be honourably associated. The American inquiry into the causes of Texas fever, and the scientific demonstration of the fact that the disease was carried by ticks, led to the scientific investigation of the causes of the many other diseases which affect our flocks and herds in this country; and whereas twenty years ago there was no bacteriological laboratory in South Africa supported by public funds, now there are at least four. The most remarkable advance has been made in the matter of discovering the means of immunising domestic animals against the manifold diseases to which they are subject in this country, and the great progress which has been attained in ascertaining the true causes of these diseases promises to lead to the discovery, in time, of the means of immunisation against all of them. It is, indeed, in the matter of fighting disease, whether amongst animals or plants, that the practical application of the results of scientific study has made its utility evident to the mass, especially to the rural portion, of the population. The mining industry has always been a scientific industry; its successful development, whether on the mechanical or on the metallurgical side, has always evidently depended on the advancement of science in its own particular spheres; but to impress on a practically minded rural population the inestimable value to themselves, and to their pastoral and agricultural undertakings, of scientific research (costly and slow as it necessarily is, and always must be) has been a work of time, and has required many object-lessons.

Let me record some of the achievements of science, in this one matter of immunisation against disease, in the course of the last ten or twelve years. A practical and effectual means of stamping out rinderpest, and of immunising cattle which have been exposed to infection, has been found. Mules can be and are effectually immunised against horse-sickness, and there are good hopes of the early discovery of a practical method of immunising horses against that disease. Although it has not been as yet found possible to immunise stock artificially against east coast fever, the investigations which have been made into that disease have made it possible to recommend precautions, which have proved successful, for preventing the disease from making its appearance on a farm, and have demonstrated the possibility of clearing infected areas. A practical method of vaccination against biliary fever, which in donkeys, mules, and horses is stated to be a success, has been discovered. The possibility of producing a serum which is stated to have a strong preventive action in cases of heartwater in cattle, sheep, and goats has been demonstrated. Methods of inoculation against blue-tongue in sheep, which are likely to prove to be of considerable practical value, have been discovered. It is scarcely necessary that I should refer to the widespread confidence which is felt, by those interested in pastoral pursuits, in the vaccines against anthrax, quarter-evil, Cape red-water, and lung-sickness, which are issued from the various Government laboratories.

As regards diseases and insect pests of plants, the plague of the Dorthesia insect, which twenty years ago threatened to extinguish the cultivation of oranges in the Cape Colony, and led to the destruction of great numbers of blackwood trees and to the abandonment of that beautiful tree for street planting, was stopped in 1892 by the introduction of the Vedalia ladybird. The discovery of this remedy was due to the scientific study of insects. Fruit trees infected with scale insect can now be safely fumigated with hydrocyanic acid gas. This remedy is essentially the outcome of scientific inquiry. The continued cultivation of the vine, which was gravely threatened by the Phylloxera, has been made possible by the introduction of the method of grafting on "American stocks." This method, which is simple, has been developed by means of an infinite amount of close study and by innumerable scientifically conducted experiments. Study of the locust problem has shown how the great swarms of voetgangers, which cause such enormous destruction of crops, and even of grass, can be annihilated easily, and at relatively slight expense, by the adoption of a method discovered and developed in South Africa. The entomologist, the chemist, and the engineer have amongst them solved the problem of the codlin moth, and it only remains for the horticulturist to apply effectually the knowledge which they have gained in order materially to reduce, or even to get rid of, the ravages of that pest of our apple orchards. There is promise that the destructive mealie-borer may prove to be controllable by simple means. This problem, as well as the problem of the fruit fly, is now being investigated in the Government laboratory at Grahamstown; and it does not seem too much to hope that before many years have elapsed the scientific plant-breeder will have succeeded in evolving varieties of wheat and oats which will fully resist rust, whilst proving quite satisfactory in other respects.

Vast strides in the matter of the study of the hybridisation of plants, and in the selection and fixing of characters of varieties, have been made during the last few years by the application of new theories of the transmission of characters, theories which were first formulated more than forty years ago by Gregor Mendel to explain the results which he obtained in crossing varieties of the sweet-pea in his monastery garden. Mendel published the result of his work in 1865, but until 1901 it appears to have been completely lost to view. Probably the good Abbot little realised the profound importance of his deductions as regards the realm of practical agriculture. Hybridising used to be described as a game of chance, played between man and plants, in which the chances were in favour of the plants. Mendel's work changed the whole aspect of the problem. His discovery, that in cross-breds the egg-cells and pollen-grains are pure with respect to the characters which they individually carry, explains many facts which were previously mysterious, disturbs the foundations of many current theories of heredity, and indicates the possibility of picking out the valuable characters from different varieties and of building up an ideal type within a reasonable time. It is on these lines that, as I understand, the Transvaal plant-pathologist is now working in his endeavours to produce rust-resisting wheats suitable to South Africa.

The value, even of the results hitherto obtained (and they are few in comparison with the results which it is yet hoped to obtain), is really beyond estimate. That the high importance of scientific inquiry is now generally recognised in South Africa is demonstrated, not only by the confidence which is now shown throughout the country in the men who have obtained the results to which I have referred, but by the establishment and flourishing growth in South Africa of our own Association for the Advancement of Science, which includes in its ranks not only men who have made some branch of science their life-study, but many who, like myself, cannot pretend to the possession of accurate scientific knowledge, but are deeply impressed with the value to this community of the promotion of scientific inquiry and research.

I have dwelt at length on the subject of the efforts of science in the matter of combating disease because it is an aspect of the question of the advancement of science which more particularly and immediately affects the practical interests of the majority of the South African community. To survey the whole field would be impossible within the available limits of time, and without exhausting the patience of my audience, even if my acquaintance with the various subjects were sufficient to justify me in dwelling on them. I should like, however, to bear my testimony to the unselfish devotion to the cause of science which is customarily shown by scientific workers in South Africa, in whatever branch of science they may be interested. In these days of scrambling after fortune, the unrewarded or scantily rewarded efforts of men searching after scientific truth with the "obstinate humility which is the crown of genius" should compel our respect, our admiration, and our material, no less than our moral, support.

I say material support, for however unselfish scientific inquirers as a class may be, however ready to devote themselves to their work without special pecuniary reward, they are not, as a rule, men of private means, and it is necessary that they should at least be provided with a sufficiency of bread and butter. Scientific research is necessarily slow. It may be years before any particular line of inquiry leads to a practical result. Long and costly inquiries, such as Koch's inquiry into east coast fever, may even have only a negative result. If, therefore, scientific research is to be pursued in South Africa in the thorough manner in which it ought to be pursued, it should be endowed in some form or other. Such endowment may come either from public sources, so that all the tax-payers contribute to it, or from private sources. It is not for me to prescribe or to suggest from which source it should come. I merely indicate the necessity. I would not, however, wish it to be understood that the South African Governments have neglected their duty in the matter of promotion of scientific research. Far from it. In Cape Colony, the Grahamstown Laboratory, where much useful work was done by Edington, was established seventeen years ago, and has since been considerably enlarged. A laboratory and experimental station, in which Lounsbury carried out those remarkable investigations which proved that the Bont tick was the carrier of heart-water, and arrived at other exceedingly valuable and interesting scientific deductions, has been established at Rosebank. The Natal Government has established a laboratory near Maritzburg, at and in connection with which Watkins Pitchford and his assistants have done much useful work, notably by making the discovery that horses could be protected against horse-sickness by the exclusion of biting insects, and in the preparation of anti-toxic sera and of anti-venene; and the Transvaal Government, after liberally subsidising Theiler's epoch-making investigations, has recently built an experimental station, at a cost of some 60,000*l.*, which will bear comparison, so far as design and facilities go, with any such station in the world. Added to this, the Cape Government, besides incurring large expenditure on rinderpest experiments, contributed liberally to defray the out-of-pocket expenses of Beattie's magnetic survey, expended large sums on Gilchrist's investigation of South African marine biology, and joined with the other South African Governments in defraying the heavy cost of Koch's inquiry into east coast fever; and the Zululand Government bore the whole of the expense of Bruce's nagana investigations. It cannot be said, therefore, that the South African Governments have been backward in this matter. Much has been done, no doubt, but more is wanted.

It is not only in connection with the investigation of diseases that research is required. It is, no doubt, the practical value of that particular line of research which has contributed in a large degree to the popularisation in South Africa of the advancement of science. But it is the educative side of scientific research that will in the end prove of the highest and most permanent value to the community. That fact has been recognised by the Transvaal Government, which has provided, in its new experimental station, for the training of students, and a small commencement has been made in the matter of training research students in the laboratories of some of the colleges in Cape Colony.

## NOTES.

WE notice with deep regret the announcement of the death of Prof. Henri Becquerel at the age of fifty-six.

AN international congress is to be held at the photographic exhibition which is being arranged to take place at Kiev from December 15, 1908, to January 15, 1909.

DR. ERIC A. NOBBS, agricultural assistant to the Cape Government, has been appointed director of agriculture in Rhodesia.

LIEUT.-COLONEL BOURGEOIS, chief of the geodetic section of the French Army Geographical Service, has been appointed professor of astronomy and geodesy in the Paris École polytechnique in succession to M. Poincaré, who has resigned.

THE herbarium formed by Mr. Duthie, and hitherto quartered at Saharanpur, has been transferred to the Imperial Forest Institute, Dehra Dun; any correspondence in connection with it should be addressed to the Imperial forest botanist of that institute.

DR. W. H. WILLCOX, lecturer on public health, pathological chemistry, and forensic medicine at St. Mary's Hospital Medical School, has been appointed senior scientific analyst to the Home Office in succession to the late Sir Thomas Stevenson.

THE British committee of the first International Congress of the Refrigerating Industries (Congrès international du Froid), to be held in Paris on October 5–12, at the Sorbonne, has issued a programme of British papers and resolutions to be brought before the congress. The various sections and the presidents are as follows:—I. Low Temperatures and their General Effects, Prof. d'Arsonval; II. Refrigerating Appliances, Prof. H. Léauté; III. The Application of Refrigeration to Food, M. A. Gautier; IV. The Application of Refrigeration to other Industries, M. E. Tisserand; V. Application of Refrigeration in Commerce and Transport, M. Levasseur; VI. Legislation, M. J. Cruppi. Lectures will be given by Prof. von Linde on refrigeration in dwelling places, and Prof. d'Arsonval on liquid air and very low temperatures. Further particulars can be obtained from the secretary of the British committee of the congress, 3 Oxford Court, Cannon Street, London, E.C.

A COMMITTEE is being formed to erect a monument to the late Prof. K. von Than, of the University of Vienna, whose death was announced recently. The monument will be set up at Ó-Becse, in Hungary, where Prof. von Than was born.

THE Oklahoma constitution contains a provision making it obligatory upon the legislature to establish a geological survey. The first State legislature passed a law placing the survey under the control of a commission consisting of the governor, the State superintendent of public instruction, and the president of the State University. We learn from *Science* that the sum of 3000*l*. was voted for the work, and that the commission has now elected Dr. Charles N. Gould, head of the department of geology in the State University of Oklahoma, to be director of the survey. Dr. Gould has been instructed to report on the building stone, road material, and oil and gas of the State.

DR. E. F. ARMSTRONG, Recorder of Section B (Chemistry) of the British Association, informs us that the following papers have been promised in addition to those already announced (July 30, p. 299):—the liquefaction of helium, Prof. Kamerlingh Onnes; anticipations and experiments on the liquefaction of helium, Sir James Dewar, F.R.S.; note on a volatile compound of cobalt with carbon monoxide, Dr. Ludwig Mond, F.R.S., and others. We are also informed that additional papers to be read in Section G (Engineering) are:—a clock-driving mechanism for equatorial telescopes, Sir Howard Grubb, F.R.S.; experiments on rotating discs, J. Brown, F.R.S., and M. F. Fitzgerald; strength of solid round-ended columns, W. E. Lilly; the study of breakages, W. Rosenhain.

As announced already, the autumn meeting of the Iron and Steel Institute will be held at Middlesbrough on September 28 to October 2 under the presidency of Sir Hugh Bell, Bart. The following are among the subjects of papers offered for reading:—scientific control of fuel supply, Prof. H. E. Armstrong, F.R.S.; metallurgy at the Franco-British Exhibition, H. Bauerman; gas-producer practice, Prof. W. A. Bone, F.R.S., and Dr. R. V. Wheeler; the constitution of carbon steels, Prof. E. D. Campbell; the freezing point of iron, Prof. H. C. H. Carpenter; the production of finished iron sheets and tubes in one operation, S. O. Cowper-Coles; the chemical control of the basic open-hearth process, A. Harrison and Dr. R. V. Wheeler; the influence of silicon on the physical and chemical properties of pig iron, A. Jouve; analysis and synthesis in the foundry, J. E. Stead, F.R.S., and T. Westgarth.

ACCORDING to a *Times* correspondent, Dr. Lee De Forest expects that within two years Paris and New York will be in direct wireless telephonic communication. An apparatus which may ultimately transmit and receive messages to and from the Eiffel Tower is to be installed upon the 700-feet tower of the Metropolitan Life Insurance Company of New York. It is reported that Dr. De Forest estimates the radius of his apparatus, when installed at an adequate height, to be about 1000 miles, but he is now working at certain improvements which he thinks will make possible Transatlantic communication. The installation on the Metropolitan tower will probably be ready by the end of the year, and the first object will be to send bulletins to ships equipped with the radio-telephonic and telegraphic apparatus. Dr. De Forest says that the length of the wire which he means to install will admit of the employment of a wave of a length long enough to be inaudible by any ordinary apparatus unless specially tuned to catch it. It is also reported by the *Times* that communication has been established by wireless telephony between the Eiffel Tower and the Pointe Duraz, on the coast of Brittany, south of Brest, a distance of more than 500 kilometres. The transmitter used at the Eiffel Tower consists of a Poulsen singing arc producing more than a million waves a second. The receiving apparatus includes the usual aërial wire and Captain Ferrée's electrolytic detector.

IN the *National Geographic Magazine* for August, Mr. L. G. Blackman, principal of Alluolani College, Honolulu, describes an ambitious scheme for the organisation of the Pacific Scientific Institution in that island, which has for its object the investigation of the Pacific Ocean, "the most explored and least known region of the globe." It is proposed to dispatch from this centre parties of trained explorers in a specially equipped vessel to the various island groups. The programme includes the collection of anthropological data; the languages, religions, laws, mythologies, legends, and genealogies will be recorded; technology, arts, and medicine will be studied; series of mammals, birds, reptiles, and botanical specimens will be collected; the coral reefs, marine fauna and flora, ocean currents, geology, and meteorology will be investigated. The survey, it is estimated, will occupy fifteen years, at the end of which reports will be issued, and progress bulletins will be published periodically. The scheme also provides for the establishment of a central museum, zoological garden, and marine biological station. Mr. Blackman, in conclusion, states that "the manner in which the institution has been incorporated and the trustees under whose administration it has been placed assure us that the long-delayed work of Pacific exploration will shortly be commenced." The increasing interest of America in the future of the Pacific will doubtless encourage her to detail for this work the many trained explorers at her disposal. The results of this important scientific survey will be awaited with interest.

A RECENT issue of *Science* contains particulars of the appropriations for the U.S. Department of Agriculture for the ensuing year. The grand total of grants amounts to 3,132,021*l*., which is an apparent increase over the previous year of 480,163*l*., or about 15 per cent. A large part of this increase, however, is only nominal, since for the present year more than 200,000*l*., derived from receipts from forest reserves, is available. The net increase is distributed through all sections of the department, and notably larger sums are available for the management of the national forests, the pure food and drug inspection, the campaign against the gipsy moth and cattle tick, and for additional buildings and equipment on the forest reserves and for the Weather Bureau. Provision is made for new investigations, and among these may be mentioned the inauguration of evaporation investigations and of studies of the prevalence and extent of tuberculosis among dairy cattle, the inspection of foods intended for export under certain conditions, and the manufacture of denatured alcohol in small amounts under farm conditions. Among the appropriations, we notice 14,000*l*. for purchasing, fencing, &c., some 12,800 acres of the Flathead Indian Reservation in Montana for a permanent national bison range, for a herd of bison to be presented by the American Bison Society. The Weather Bureau is to receive 332,452*l*., an increase of 40,744*l*. Of this amount, 12,000*l*. is for the erection of a main observatory building at Mount Weather, Va., to replace that destroyed by fire on October 23, 1907. The Bureau of Animal Industry is to benefit by 216,172*l*., an increase over last year of 9660*l*. The emergency appropriation for the eradication of the cattle tick in the south is increased from 30,000*l*. to 50,000*l*. The Bureau of Plant Industry receives an apparent net increase of 57,000*l*., and the Bureau of Chemistry an increase of 25,760*l*., chiefly for additional expenses incident on the enforcement of the National Food and Drug Act.

The appropriation for the Bureau of Soils is increased to 46,040*l*., that of Entomology to 36,992*l*., while the total appropriation for the Office of Experiment Stations is 206,924*l*., an increase of 4280*l*.

According to the report for 1907, the Albany Museum, Cape Colony, continues to make steady progress, but the congested condition of the collections, owing to insufficient accommodation, necessarily tends to hinder expansion. By the death of Mrs. George White, of Brakkloof, near Grahamstown, the museum has lost a liberal and constant benefactor.

In vol. xvii., part v., of the Proceedings of the Royal Physical Society of Edinburgh, Prof. J. A. Thomson records from the Færoes a large antipatharian coral hitherto unknown from the British area, and provisionally identified with a well-known Mediterranean species, which has been stated to occur in the Bay of Biscay. The single Færoe specimen, which is more than a yard in height, was dredged up by a fisherman.

From the author, Mr. M. Doello-Jurado, we have received a copy of an "Essai d'une Division Biologique," extracted from *Annales de la Sociedad Cientifica Argentina*, vol. lxv., pp. 189 *et seq.*, 1908. In this it is proposed to divide vertebrates into two main groups, according to their mode of fecundation. In the one group fertilisation of the ovum takes place within the body of the female parent, while in the other this process is external. "Vertébrés à fecondation interne" are further divided into an oviparous and a viviparous subgroup.

In the double July and August number of *Naturen*, "J. G." records the capture of a specimen of Sowerby's beaked whale (*Mesoplodon bidens*) at Bergen. These cetaceans seem much less uncommon on the coasts of Norway than on our own shores, three specimens having, to our own knowledge, been taken at Bergen during the last few years. The new specimen is unusually small, and probably, therefore, immature, its length being only 2·45 metres, whereas normally adult examples attain about double this length.

To Mr. B. B. Woodward we are indebted for a separate copy of his presidential address delivered before the Malacological Society in February last, and published in vol. viii., part ii., of the society's Proceedings. The title is "Malacology *versus* Palæoconchology," and attention is specially directed towards an alleged lack of harmony existing between the works of students of recent and of fossil Mollusca. Workers in the existing group are accordingly asked to check their results by a comparison of the labours of palæontologists, while the latter are urged to desist from the practice of brigading together groups which have been shown by the former to have no near relationship. A useful table of the time-distribution of the leading molluscan groups is appended.

To the August number of *British Birds*, Mr. C. B. Ticehurst contributes the results of an inquiry into the recent outbreak of wood-pigeon diphtheria, of which the distribution is illustrated by a map. The disease, it appears, has been familiar to sportsmen and gamekeepers for some years as being liable to occur in seasons when acorns and beech-mast are abundant, but its true cause was unknown. The disease was in the main confined to the Thames valley area, and appears to have been most prevalent among the migratory birds which arrived in autumn from the Continent. It is suggested that the contagion was communicated by one bird swallowing food that had been coughed up from the gullet of another. The course of the malady may be either rapid or lingering. The active cause of the disease is the presence in the mucous membrane of the throat of a bacillus believed to be specifically distinct from the one which causes diphtheria in the human subject.

The second part of vol. xci. of *Zeitschrift für wissenschaftliche Zoologie* contains a very detailed account of the minute structure of the eyes—compound and simple—of the fresh-water crustacean *Apus productus*, by Dr. W. Wenke, of the Zoological Institute, Berlin. The investigation was taken up as a further development of Hesse's "Untersuchungen über die Organe der Lichtemfindung bei niederen Thiere." Without entering into the results of the investigation, attention may be directed to the elaborate nature of the text-figures illustrating the histology of the compound eyes. Incidentally, it may be mentioned that *Apus productus* seems to be as capricious in its appearance as the British *A. cancriformis*. In 1901 females were, for instance, abundant in the neighbourhood of Berlin, but for several years afterwards the author could obtain no other specimens until he found the species common at Fürstenbrunn in 1906 and 1907. Owing to the cold spring the species at that place has this year attained only two-thirds its normal size.

Few food problems are more important than the development of bacteria in milk, and the dairy farmer is fast recognising that micro-organisms are the cause of many of his troubles. Elaborate apparatus has been devised for cooling, pasteurising, and sterilising milk, and is being used to a large and increasing extent in modern dairies. Bulletin No. 111 of West Virginia University Agricultural Experiment Station gives a full description, with illustrations, of some of the methods used in America, and will prove very useful to those interested in the technical side of bacteriology.

An interesting batch of bulletins has reached us from the Agricultural Experiment Station of the Purdue University (Indiana, U.S.A.), some dealing with local practical problems and others of more general interest. In No. 119 is given a list of the plant diseases occurring in the State for the year 1906, with an indication of their relative prevalence. The basis for the estimation of losses and the distribution of the diseases was a large number of reports furnished by correspondents all over the State. The value of such a list, both from the scientific and the economic point of view, is obvious, and some of our agricultural institutions would do well to draw up similar lists for the areas they serve.

A number of the "Progressus Rei Botanicæ," prepared by Dr. J. W. Moll, and published for the International Association of Botanists, is devoted to the review of the progress in microscopic technique since the year 1870. With regard to the microscope and its component parts, water immersion objectives were already in use prior to that date, but oil immersion objectives are innovations and apochromatic lenses are more modern. The author regards the Abbé condenser and revolving nose-pieces as the most practically useful devices that have been introduced. Allusion is made to the investigation of ultra-microscopic particles and microphotography with ultra-violet light, but more information would have been acceptable. A discussion is presented of the opinions held with regard to the value of fixing and staining methods, in which Dr. Moll disagrees in the main with Fischer's criticisms. It is noted that the method for preparing paraffin sections in ribands was first announced by F. Spee in 1885. Reference is made to certain physical tests, of which De Vries's plasmolytic method is the best known.

The failure of Scots pine when planted on farm lands has been so pronounced in many parts of the Continent that the matter was referred to Prof. Albert for investigation. Mr. B. Rippentrop furnishes an account of the work, so far as it has gone, to the Transactions of the Royal Scottish Arboricultural Society (vol. xxi., part ii.). There is no difficulty in connecting the failure with the fungus *Polyporus annosus*, but the question remains whether the fungus is the primary cause of the disease. On forest lands, although the Polyporus is present, the trees do not suffer, and it appears that the difference lies in the physical condition of the soil. On farm lands it was observed that nearly all the trees showed disease of the roots, and it is inferred that when the trees are thus weakened they fall a prey to the fungus. The interplanting of hard-wood trees, notably of species of Acacia, leads to an improvement of the soil by which the conifers are benefited.

The Upper Gila and Salt River valleys of Arizona and New Mexico, the antiquities of which are the subject of a monograph by Mr. Walter Hough in the thirty-fifth Bulletin of the Bureau of American Ethnology, form part of the States of south-eastern Arizona and south-western New Mexico, close to the southern boundary of the Republic. This region at one time provided a home for numerous hunting and pastoral tribes, some inhabiting the higher forest belt, which now constitutes the greatest virgin forest remaining in the United States, others cultivating the fertile valleys watered by the streams which descend from the higher ridges. The abundant remains of cliff dwellings, pueblos, and the cemeteries in which the inhabitants buried their dead, prove that this country was at one time thickly peopled. When and why they disappeared is not known; it was certainly prior to the famous exploration by Francisco Vasquez Coronado in 1540. Large collections of their pottery, clothing, and other manufactures have been made from the numerous cliff dwellings and pueblos which sheltered this now forgotten race. Everything indicates that they had attained a fairly high culture. They must have been able to combine in the construction of works of national importance, as, for instance, in building the gigantic irrigation dam in the Animas valley, New Mexico, an earthwork $5\frac{1}{2}$ miles long and from 22 feet to 24 feet high. Of their language we know as little as of their history, the petroglyphs on smooth rock surfaces showing only rude figures of men and animals, with various symbols which have up to the present defied interpretation. Mr. Hough's report is a good example of the careful work performed by the Bureau of Ethnology.

The latest additions to the useful and compact series of "Manueli Hoepli" are a volume by Lanfranco Mario on frauds in electrical meters ("Le frodi nei misuratori ellettrici"), and one by Prof. Vincenzo Reina, the indefatigable treasurer of the recent Mathematical Congress, on optical instruments ("Teoria degli Strumenti diottrici") (Milan: Ulrico Hoepli, 1908, prices 4.50 and 3 lire respectively). Dr. Lanfranco deals with the problem of "sealing" sources of electrical energy in connection with the Italian Government duty on electric power, and his book treats generally of the question of fraud in the working of electric meters, or in connection with the so-called sealing in question, as well as its means of prevention. Prof. Reina's handbook may be described as an elementary treatise on geometrical optics; it deals with the laws of refraction, the relations between conjugate foci in a system of coaxial lenses and such instruments as the compound microscope, telescope, and telephotographic lens. The author's treatment of the subject is simple in character, and does not include elaborate discussions of aberrational and other errors.

We have received the "Atti della Società italiana per il Progresso delle Scienze," a society which was recently founded on lines similar to the British Association and other organisations of the same kind, and held its first annual meeting in Parma on September 23–28, 1907. The association includes the following sections:—(1) mathematics, astronomy, geodesy; (2) physics, geophysics, meteorology; (3) mechanics, engineering, electrotechnics; (4) chemistry; (5) botany; (6) geography; (7) mineralogy, geology, palæontology; (8) botany; (9) zoology and comparative anatomy; (10) anthropology; (11) anatomy; (12) physiology; (13) pathology and bacteriology; (14) economics and statistics. The present volume contains a summary of the proceedings, together with reports *in extenso* of the inaugural addresses by the Mayor of Parma, Prof. Vito Volterra, president of the association, and the Minister of Public Instruction; the general lectures by Prof. G. Ciamician on organic chemistry in organisms; by Prof. P. Foà, on the biological significance of tumours; by Prof. M. Pantaleoni, a kinematographic view of progress in economic science, 1870–1907; and sectional addresses by Profs. V. Cerruti, A. Righi, L. Luiggi, M. Ascoli, E. Paternò, G. Cuboni, G. dalla Vedova, A. Issel, A. Borzì, A. Andres, G. Sergi, G. Fano. The next meeting will take place in Florence in September of this year.

We have received the report for 1907 of the Liverpool Observatory maintained at Bidston (Birkenhead) in the interest of shipping by the Mersey Docks and Harbour Board. A signal gun is fired daily at 1h. p.m., and chronometers, sextants, and other apparatus are tested for shipmasters. The meteorological observations are very complete, and include indications from Dines's, Osler's, and Robinson's anemometers. The daily meteorological results show the extreme and mean values, the amount and duration of rain, and the number of hours that the wind blew from each of eight points of the compass. The absolute maximum temperature of the year was 76°·0, in July, and the minimum 20°·4, in January: the mean for the year was 0°·7 below the average. The rainfall was 26·57 inches, practically 2 inches below the average; rain was recorded on 209 days. Among other useful work performed we note that reports are supplied daily to the Meteorological Office for the preparation of its weather forecasts. Some details connected with the records of a Milne seismometer are included in the observatory report.

The University of Illinois Engineering Experiment Station has recently issued Bulletin No. 23, "Voids, Settlement and Weight of Crushed Stone," by Mr. Ira O. Baker. This bulletin gives the results of some experiments to determine the proportion of voids in crushed stone loaded by various methods in cars and in waggons, to find the amount of settlement during transportation in waggons and in cars, and also to obtain the relation between the weight of a unit of volume of the solid stone and that of the same volume of crushed stone immediately after being loaded in various ways into cars and waggons, and also after being transported different distances. Copies of this bulletin may be obtained gratis upon application to the director, Engineering Experiment Station, Urbana, Illinois.

An article on "England's Neglect of Mathematics," contributed by Prof. G. H. Bryan, F.R.S., to the August number of the *Cornhill Magazine*, should do something to awake the British nation to a sense of its duties to science.

A number of instances are given of the value of mathematical research, and a plea is made for greater encouragement for mathematicians and more serious work in higher education. For example, as Prof. Bryan points out, "Before the mathematical theory of stability had been developed many ships were sunk and many lives lost which could have been saved if the problem had been properly placed in the hands of the mathematician. It was only after these losses took place that the theory of the metacentre was finally evolved, and the problem of stability was reduced to one of pure arithmetical calculation. If one-tenth of the money expended in building these ill-fated ships had been offered to a really competent mathematician possessing the highest knowledge of his subject, to enable him to devote his whole time for a year or so to this particular problem, the saving to the community would have been immense. Yet a similar drama may be enacted at the present day in connection with artificial flight, for while the mathematical theory of stability has been outlined there is a great deal of work to be done before the results can be reduced to simple practical rules."

A FORM of cadmium cell suitable for supplying a small current much more constant than can be obtained from a storage cell is described by Mr. G. A. Hulett, of Princeton, in the July number of the *Physical Review*. A wide-necked bottle of about 8 cm. diameter contains a layer of mercury half a centimetre thick covered to a depth of 4 cm. or 5 cm. by a solution of 10 c.c. of strong sulphuric acid and 800 grams of cadmium sulphate crystals per litre of water. A glass tray about 4 cm. diameter and 4 mm. deep is supported in the solution a little above the surface of the mercury, and contains the $12\frac{1}{2}$ per cent. cadmium amalgam. Contact is made with the mercury and the amalgam by means of wires enclosed in tubes. The mercurous sulphate is prepared in the cell by sending a current through the cell from the mercury to the amalgam, the solution being kept well stirred during the process. The internal resistance of such a cell is about 6 ohms, and it is capable of giving a current of 0·00001 ampere for many days without its electromotive force varying appreciably. A larger cell has been used to give a constant current of 0·04 ampere for a long period for bolometrical work.

IN the case of the majority of the ions Prof. Arrhenius's assumption that the mobility is independent of the concentration holds good through a considerable range of dilute solutions, though variations occurring in stronger solutions are well known, and have been investigated by Jahn, by Bousfield, and by others. The hydrogen ion appears, however, to be an exception. For some years doubt has existed as to the correct value for its mobility, transference experiments at moderate dilutions having given a value 330, considerably higher than the value 315 deduced from conductivity measurements at extreme dilutions. This discrepancy has been traced by Noyes and Kato, who describe their observations in a recent number of the Journal of the American Chemical Society, to variations in the mobility of the hydrogen ion occurring at dilutions much greater than those at which the mobilities of the other ions become constant. Concordant values were obtained from independent observations with hydrochloric and nitric acids, and the evidence for the reality of the variations of mobility appears to be complete. The numbers given in the following table show the magnitude of the changes involved :—

| | | | | | | |
|---|---|---|---|---|---|---|
| Concentration | $HNO_3$ | 0·058 | 0·0184 | 0·0067 | 0·0022 | 0 |
| | HCl | 0·051 | 0·0170 | 0·0056 | 0·0021 | 0 |
| Mobility ... | $HNO_3$ | 350·3 | 340·2 | 339·1 | 332·2 | 324·6 |
| | HCl | 344·2 | 340·5 | 341·4 | 331·8 | 324·0 |

THE Harben lectures of the Royal Institute of Public Health, delivered by Prof. Paul Ehrlich last year upon the subject of "Experimental Researches on Specific Therapeutics," have been published by Mr. H. K. Lewis, Gower Street, in the form of a small volume, having a portrait of the lecturer as a frontispiece. The price of the volume is 2*s*. 6*d*. net.

FOR the third year in succession the Library Association has published its "Class List of Best Books and Annual of Bibliography." The work is a classified and annotated catalogue of important works which appeared in the year ended on June 30. The previous year's issue comprised 1800 titles; this year the number has risen to more than 2500. The publication should be useful both to the general reader and the student as a guide to recent literature of noteworthy value.

THE third edition of Prof. H. Snyder's "Soils and Fertilisers" has just been published by the Macmillan Co., New York. The second edition was reviewed in NATURE of January 18, 1906 (vol. lxxiii., p. 266); and though the work has been enlarged and revised, no further description of its contents is necessary. It is sufficient here to say that the book presents in a concise form the scientific principles involved in the successful treatment of the soil and the production of crops.

## *OUR ASTRONOMICAL COLUMN.*

THE ORIGIN OF THE RECENTLY DISCOVERED JOVIAN SATELLITES.—Criticising Prof. Forbes's recent suggestion (NATURE, p. 30, No. 2011, May 14) that the newly discovered eighth satellite of Jupiter may in reality be the long-lost Lexell's comet of 1770, captured by the giant planet in 1779, Prof. Tarrida del Marmol conjectures that a more likely explanation of the origin of the sixth, seventh, and eighth satellites is to be found in the suggestion that they are asteroids which revolved at the same distance from the sun as Jupiter, and were captured by the latter. He shows that if the asteroid be either further away from, or nearer to, the sun, the annexation cannot take place, but when the distances are equal the asteroid will, with its relatively negligible mass, be effectively the inferior planet, and will suffer capture. The recent discovery of the four Jovian asteroids Achilles, Patroclus, Hector, and 1908 C.S., strengthens the possibility of this conjecture. Prof. del Marmol concludes his note, which appears in the August number of *Knowledge and Illustrated Scientific News* (vol. v., No. 8, p. 185), with the tentative suggestion that the Saturnian satellites Hyperion, Themis, and Phœbe may have been captured by Saturn in the same manner.

In answer to our inquiries concerning the above suggestions, Mr. Melotte, the discoverer of Jupiter's eighth satellite, points out that the images found on the plates give no indication whatever of diffuseness, such as might be expected from a cometary body, but are in every respect similar to the photographed images of the other faint satellites. According to Hind, Lexell's comet, when nearest the earth, exhibited a white nebulosity surrounding the nucleus and subtending an angle of 2° 23′, although no tail was visible. Mr. Melotte also suggests that others of the major planets may be attended by satellites hitherto undiscovered by reason of their faintness, and that the motions of these may subsequently be found to be retrograde, thus reducing the importance of the anomalies which have hitherto puzzled astronomers in considering the origin of the satellites under discussion. In conclusion, he adds that possibly Prof. del Marmol intended to write Japetus in place of Themis, as, so far as is known, the latter rarely reaches a distance of 220″ from Saturn.

ELEMENTS OF THE ORBIT OF JUPITER'S EIGHTH SATELLITE.—Circular No. 102 from the Kiel Centralstelle contains the following equatorial elements for the orbit of Jupiter's eighth satellite, computed by Messrs. Crawford and Meyer and communicated telegraphically by Prof. E. C. Pickering:—

$$\begin{aligned} T &= 1908 \text{ August } 25{\cdot}72 \\ \omega &= 51^\circ\ 9' \\ \Omega &= 236^\circ\ 12' \\ i &= 145^\circ\ 48' \end{aligned} \Bigg\} \ 1908{\cdot}0$$

$$q = 0{\cdot}103 \qquad e = 0{\cdot}4395 \qquad \text{Period} = 2^{a}{\cdot}55.$$

Osculation, 1908 March 8, 19h. 45·5m. G.M.T.

SEARCH-EPHEMERIDES FOR COMET TEMPEL$_3$-SWIFT.—Three ephemerides for the comet discovered by Tempel in 1869, and recognised as periodical by Swift in 1880, are published by M. E. Maubant in No. 4269 of the *Astronomische Nachrichten* (p. 349, August 14). These ephemerides give the positions of the comet from August 29 to November 1, the times of perihelion being taken as September 22·88, September 30·88, and October 8·88 respectively. The following is an extract from the ephemeris for the mean date:—

*Ephemeris (12h. M.T. Paris).*

| 1908 | α (h. m.) | δ (° ′) | log $r$ | log Δ |
|---|---|---|---|---|
| Aug. 29 ... | 4 18·8 ... | +30 39·0 ... | 0·0879 ... | 9·8615 |
| Sept. 2 ... | 4 40·0 ... | +31 27·9 ... | 0·0822 ... | 9·8542 |
| ,, 6 ... | 5 1·5 ... | +32 3·5 ... | 0·0771 ... | 9·8484 |
| ,, 10 ... | 5 23·0 ... | +32 25·4 ... | 0·0727 ... | 9·8440 |
| ,, 14 ... | 5 44·3 ... | +32 33·5 ... | 0·0689 ... | 9·8409 |

From this ephemeris it is seen that the comet is travelling eastwards through Taurus to Auriga, and may be discovered during the early morning before dawn. Its period is about $5\frac{1}{2}$ years, and it was well observed in 1891, although at its more recent returns in 1897 and 1903 it was not seen. On September 9 the comet should be about 4° N. of $\beta$ Tauri, which rises about 10 p.m.

DEFINITIVE ORBIT OF COMET 1826 V.—No. 4269 of the *Astronomische Nachrichten* (p. 341, August 14) contains a discussion, by Herr A. Hnatek, of Vienna, of the orbit of comet 1826 V, from which the author deduces that the orbit was parabolic, the most probable ellipse giving a period of nearly 28,000 years. Herr Hnatek directs attention to the fact that in the early hours of November 18, 1826, the comet grazed the sun.

RELATIVE DEPTHS OF THE SUN-SPOTS OF A GROUP.—Discussing stereocomparator measures which he has made on photographs taken at Greenwich on July 4, 5, and 6, Prof. Wilhelm Krebs, in No. 4267 of the *Astronomische Nachrichten* (p. 315, August 7), shows that the different spots of the group which was then near the central meridian were at different levels, and also that the changes of level varied from spot to spot during the intervals between the taking of the photographs. Whilst the most easterly spot showed a sharp increase of height above the datum line, the most westerly exhibited a sharp fall. The different heights, measured in 1000 km., varied from 137 to −3, whilst the general increase in height during the two intervals amounted to 17,000 km., or 27 per cent.

## AN ALLEGED EXCRETION OF TOXIC SUBSTANCES BY PLANT ROOTS.[1]

THE idea formulated a century ago by de Candolle that plant roots excrete toxic substances has recently been very much pushed forward by the American Bureau of Soils to explain the effects of fertilisers and the advantage of a rotation of crops. The American method of experiment is to grow seedlings in water culture for a few days and measure the amount of transpiration, which is considered to be an index of the amount of growth. The seedlings are then removed and replaced by a second batch, without changing the water; the rate of transpiration is found to be diminished, showing (it is stated) that a toxic body excreted by the roots of the first batch is adversely affecting the second. Further, seedlings grown in an aqueous extract of certain poor soils are found to transpire less water than others grown in distilled water, and it is concluded that these soils contain some toxic material, presumably excreted by plants. The toxic body is, however, precipitated on addition of charcoal, ferric hydrate, and solutions of various manures; and the Bureau of Soils argues that the function of fertilisers, in some cases at any rate, is not to feed the plant, but to precipitate the toxin excreted by previous plants. Rotations of crops are of advantage, because the toxin excreted by one plant is not necessarily harmful to plants of a different order.

It cannot be said that any very convincing evidence is offered in support of this view. The assumption that transpiration is a measure of plant growth is not borne out by any of the figures quoted; thus in a series of experiments given in Bulletin No. 36 the crop weights and transpiration results are:—

| Experiment | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Transpiration | 100 | 126 | 116 | 107 | 116 | 133 | 119 | 147 | 111 |
| Crop weight | 100 | 108 | 95 | 100 | 103 | 112 | 107 | 129 | 108 |

Another weak point is that the experiments are made with seedlings, and last only a few days, instead of being carried on to the end of the plant's life. The nutrition of the seedling is not the same as that of the plant, and even if it were demonstrated that secretion from seedling roots took place, it would not follow that there was a similar secretion from the roots of fully grown plants.

In the last Bulletin from the Soil Bureau (No. 48) an account is given of more than 13,000 pot trials with soils from different parts of the United States. The results show, as might be expected, that addition of manures increases the crop, and that each manurial substance exerts a specific effect which is not shown by any other; with this statement everyone would agree. The further conclusion is drawn that the character of fertiliser required depends more upon local conditions and practices than on the type of soil or the geological formation to which it belongs, so that the fertilisers required for the same type of soil as it occurs in different localities usually vary more than those required for very different types when in the same locality and subjected to similar environment. If this generalisation turned out to be true, it would be more easy to reconcile with the plant excretion view than with the nutrition view of the function of fertilisers, but an examination of the tables does not show that there is any proof. Averages are taken without any regard to their probable value. Thus in one section of the table we find three soils only, and they give the following percentage increases when treated with various manures, yet the author finds no difficulty in taking an average:—

| Soil | Percentage increase given by manures supplying | | |
|---|---|---|---|
| | Potash | Phosphoric acid | Lime |
| Cecil sand ... ... ... ... | −8 | −15 | 8 |
| Cecil sandy loam ... ... ... | 3 | 40 | 33 |
| Iredell clay loam ... ... ... | 6 | 0 | 3 |
| Average ... ... ... ... | 0 | 8 | 15 |

The magnitude of the experimental error can only be inferred from one table, where the separate crop weights for twenty pots are given; it would appear to be considerable, since the weights vary from 58·7 grams to 89·9 grams; but the author groups the pots in sets of five, and in this way reduces the error to 5 per cent., which is given as the probable error for all the experiments! There

[1] (*a*) "Fertility of Soils as affected by Manures." By Frank D. Gardner. (U.S. Department of Agriculture, Bulletin No. 48.)
(*b*) "Note on a Toxic Substance Excreted by the Roots of Plants." By F. Fletcher. (Memoirs of the Department of Agriculture in India, vol. ii., No. 3.)
(*c*) "Crop Rotation and Soil Exhaustion." By F. Fletcher. (Cairo Scientific Journal, vol. ii., No. 19.)

would be no particular difficulty in maintaining any thesis if results could be treated in this way.

Mr. Fletcher's work has been partly on the above lines. He obtained a "solution of excreta" by growing plants in water culture, and then used this solution as a medium for plant growth. It proved to be toxic, and the conclusion is drawn that the plant first used excreted some poisonous body. The experiment, however, is not a very good one. It is well known by those who have worked with water cultures that bacterial decompositions are liable to take place in the solution, producing substances injurious to plants; precautions always have to be taken to prevent development of bacteria. It does not appear that any such precautions were taken by Mr. Fletcher, indeed, the conditions under which he worked seem to have been favourable to bacterial development; well water was used, and the "solution of excreta" was allowed to evaporate at ordinary temperature until sufficiently concentrated for the second part of the experiment. There is no evidence that the toxic substance was excreted by the plant; it might equally well have been a bacterial product.

In another set of experiments crops were grown in rows side by side, and three lots of measurements were taken:—(1) the yield in the outside row, bordering on the bare ground; (2) the yield in the middle row; (3) the yield in a row bordering on another crop. The first is the highest, the second shows the effect of the plant on others of the same kind, and the third shows the effect on others of a different kind. The falling off in yield in the second and third cases is regarded by Mr. Fletcher as proof of a toxic excretion; it is generally explained as due to lack of water or food, and no satisfactory evidence is adduced against this view; indeed, Mr. Fletcher states that the reductions in crop are less marked under a more evenly distributed rainfall. We cannot consider that the question of root excretion has been materially advanced in any of these publications. E. J. R.

## ACID-RESISTING ALLOYS.

A PAPER was read at a recent meeting of the Faraday Society by Mr. Ad. Jouve describing the remarkable resistive character of ferro-silicon and other silicon alloys. Attention was directed to the fact well known to analysts that no methods of analysis for this substance, based upon the use of acids, with the exception of hydrofluoric acid, are employed for ferro-silicons, because ferro-silicon containing more than 20 per cent. of silicon is insoluble in acids. This protective property of metalloid is being made use of in producing acid-resisting vessels. Ferro-silicons, however, are not the only substances which possess this property; almost any alloy of a metal with this metalloid will behave in the same way to a greater or lesser degree, according to the nature of the metal. Calcium-silicide is, for example, unaffected by acid, whereas calcium itself acts vigorously upon water.

As showing the resistance of these alloys, which are called "Métillures," to acids, the following example is interesting:—Nitric acid, even as a vapour such as is obtained at the exit of a bisulphate retort or when mixed with nitrous acid, does not affect them at all. A striking example of this is given by a pipe which has been submitted for nearly five years to the daily passage of 660 lb. of nitric acid vapour at temperatures varying from 150° to 200° C. without its loss in weight exceeding a few decigrams in a total weight of a score of kilograms. This loss occurred quite at the beginning of the period, and was probably due to a few impurities remaining on the inner surface of the pipe after fusion.

Sulphuric and hydrochloric acid appear to have still less effect, and pipes of ferro-silicon have been used for carrying and condensing gaseous hydrochloric acid. Acetic acid and the mixture produced by treating calcium acetate are also without action. Seeing the extremely high price of platinum, which is the most stable of all industrial metals, it would appear probable that the advent of these new resisting alloys will become of very considerable importance. The chief drawback to their use is in the brittleness and weight of the alloy, the vessels made of it being generally rather thick.

## CERTAIN ASPECTS OF THE WORK OF LORD KELVIN.[1]

WHEN a man of the first magnitude works continually at a single group of subjects from an age preceding twenty to an age exceeding eighty, the circumstance is so exceptional and the output so enormous that no ordinary summary or criticism can do it justice.

I shall not aim at any chronological sequence, and, in fact, propose to begin with those later physico-philosophic views which seemed to determine the direction of his thoughts and the attitude of his mind to nascent and contemporary discoveries in recent years.

For this aspect, even if difficult to treat of, is one which a biographer is bound in some fashion or another not to shirk; and, although myself unable to regard it with full sympathy, I am confident that my point of view is neither presumptuous nor disrespectful.

### KINETIC THEORY OF SOLIDITY.

Now, I confess that for some years before his death Lord Kelvin's attitude to fundamental physical or philosophical questions was somewhat of a puzzle to me. He seemed to be abandoning ground which he himself had opened up to explorers, and discouraging others from advancing in directions where he himself had pioneered. As a matter of fact, I was uncertain whether his position was even consistent and logically tenable or not; and at the British Association meeting at Leicester, during a discussion on the constitution of the atom in Section A, I had an opportunity of respectfully and deferentially challenging him on this subject. He responded, as always, in the kindest manner, and with great and almost exceptional lucidity indicated what had now become his position. I would not be understood as implying that he carried conviction, or led me to regard that position as a desirable one to occupy; but he showed it to be a consistent and logical one, which he had every right to occupy if he chose, and on which, therefore, it must be left for posterity, or at least for effluxion of time and progress of discovery, to pass anything in the nature of ultimate judgment.

I was much interested in this pronouncement, and before leaving Leicester jotted down a few notes concerning it, with the view of publishing them in his lifetime, in order that he might, if he chose, add to, or subtract from, or modify the statement. Other things prevented rapid publication, however, and accordingly it is too late for one of the objects in view, but still the notes are worth publication as suggesting genuine antithetical or alternative views of the universe. (They have now appeared in NATURE for July 2, 1908.)

It may seem as if the real antithesis was between the postulates of a connecting medium, on the one hand, and of action at a distance across empty space, on the other, and as if Lord Kelvin were in favour of the latter view. I do not, however, think it would be fair to attach to him that responsibility. I think it was more a matter of practical politics, with him, than a philosophical conception. I think he would have liked to see an explanation in terms of a connecting medium, if it could have been managed; but, after spending some years in the attempt, he abandoned it either as too difficult or as hopeless, and constrained himself to be satisfied with unexplained forces between masses of matter acting according to specified laws; the question of the medium or mechanism through which they acted being left out of account as unnecessary from the point of view of practical dynamical calculation and consistent reasoning.

He did speak at times, however, as if immediate action across empty space would be logically satisfactory to him, and quite good enough as an explanation; the only question being, was it the true one? To me I confess that any such philosophic scheme must necessarily be a cold and merely descriptive account of material activity—that it must necessarily fail to go to the heart of the matter or to constitute what may more reasonably be called "explanation." The conception of forces acting according to a specified law of distance is capable of yielding dynamical results truly, but not of explaining them. Ex-

[1] Abridged from the presidential address to the Faraday Society, delivered by Sir Oliver Lodge, F.R.S., on May 26.

planation, however, is never ultimate; so it may be that the process contemplated, and in his last years energetically worked at, by Lord Kelvin is an intermediate stepping-stone, which must be taken in order to cross to some more stable resting-place beyond; just as has happened in the case of gravitation.

The above is an attempt fairly to represent what I conceive must have been in the mind of our great leader, and it was a kind of pronouncement which I hoped to draw from him by the publication above mentioned. If he had been living it would have been presumptuous to try and state more concerning his views than he himself had indicated; and still it is to be hoped that anyone acquainted with his mind on this matter will make the necessary corrections.

### ENERGY.

If we now proceed to ask what great generalisation will for ever be associated with Lord Kelvin's name, and in future ages stand out as his greatest achievement, it is not easy amid the wealth of material to focus it clearly. A few days ago I myself should not have been certain, if suddenly catechised, what my answer would be to such a question. But in preparing this address, and reading once more some of his early papers, I find nothing greater than what emanated from him in and about the year 1851, when he was immersed in the doctrine of energy. I do not mean, of course, any single year exactly, but about that period of his life; for in the records of that time are to be found, I think, his greatest and strongest memoirs.

The keenness and penetration of his mind at that epoch must have been something astounding. With all his mathematical powers alert, with tremendous natural genius, and extraordinarily vivid interest in phenomena of all kinds, he seized the facts concerning energy as they emanated from Carnot and from Joule, and with them in his mind, more powerfully and persistently than even Helmholtz, he brooded over the whole domain of physics until he elicited therefrom a series of the most beautiful and striking discoveries—discoveries which, as they have gained in familiarity, have perhaps lost something in charm, by constant iteration in text-books and college lectures, but which, in their freshness, well repay an attentive perusal; though their form is far inferior to their substance.

So I expect that the answer of posterity, to the question above mooted, will be that his most immortal work is the development and application of the doctrine of the conservation of energy, together with the comprehension and elaboration of the laws of thermodynamics.

Later he became more immersed in the work of the world, managed a great deal of practical business, and made many inventions of surpassing ingenuity; but although all this later work is the best known to the general public—if, indeed, any scientific work can be said to be really known to that body—yet for pure genius, to my mind, nothing since Newton comes up to his achievement in the fifth and sixth decades of the last century, especially from 1848 to 1856.

The comprehensive recognition, and extraordinary application to physics, of Carnot's brilliant "Reflections on the Motive Power of Fire," or, as we should now say, *On the efficiency of heat engines*, must have been largely due to Lord Kelvin's influence, and to the clear and enthusiastic way in which he took up and developed the subject. It is singular that this discovery of the second law of thermodynamics, which came historically first, created a real difficulty and obstruction in the recognition of the truth of what is now called the first law; and Joule's work would not only have been rejected by the Royal Society, as it was, but would have met with a total lack of recognition, or even disdain, had it not been for Lord Kelvin's perception of its value at a meeting of Section A of the British Association in 1847. In fact, the development of the whole subject of thermodynamics, though extensively carried out by Clausius and others, must have received strong initiative from him.

But it was not the mere recognition of the true nature of heat as a form of energy—so that when work was done by a fall of temperature the heat removed was less than the heat supplied, thereby breaking down the hydraulic analogy—but it was the way in which, both by Lord Kelvin and Helmholtz, the conservation of energy was applied all over the ground of physics, and especially so as to incorporate electrical phenomena with the rest, in one scheme, that was most remarkable.

Of all the memoirs dealing with the conservation of energy as applied to electricity, perhaps the most striking, though one of the simplest, is Lord Kelvin's early paper on transient currents, or the discharge of an electric capacity; wherein he gives the whole theory of electric oscillations, in so far as they can be treated without recognising the radiation which accompanies them—a discovery reserved for Maxwell. . . .

The extraordinary magnitude of the giants in physical science, especially in mathematical physics, during the Victorian era, and, indeed, throughout the nineteenth century, will probably be recognised more fully by posterity than by us. It will be many generations, probably many centuries, before the general and literary world can receive any adequate impression on the subject, or begin to understand their methods and their more recondite results.

### SPECIFIC HEAT OF ELECTRICITY AND VOLTA FORCE.

It seems to me an amazing piece of insight which led Lord Kelvin at that date, 1851, to attribute to electricity, even hypothetically and only for convenience, something akin to real specific heat. The fact was really discovered in 1851, though he did not verify it experimentally until 1856 (see pp. 246 and 319, &c., of that monument of human power, vol. i. of "Math. and Phys. Papers"). The modern theory of electrons—which are now supposed to be flowing in great crowds through a conducting metal, and which, by their irregular motions, must account for some of the heat energy of a substance, in addition to the much larger portion corresponding to the motion of the atoms—seems to justify this curious expression, "specific heat of electricity," to an unexpected degree; and thermoelectric phenomena may be stated in terms of a definite pressure of these mobile and detached electrons in any given substance, after the fashion of the pressure of a gas or the osmotic pressure of a salt dissolved in a liquid.

There is, indeed, no obvious reason for denying that the Volta force might be expressed in this way too, were it not that a perfectly valid *vera causa* for this effect is to be found at the surface of the metals, where they are in contact with air or other chemically potential material; and that the magnitude of the effect, so calculated, from electrochemical and thermal data, agrees with observation in absolute as well as in relative value. These and other facts lead me to maintain that Volta force is an incipient display of potential but not actual chemical activity, at the bounding surface of a metal and a dielectric. But I ought to say that Lord Kelvin differed from this view in 1884, and that he still might not agree with all that is implied in this summary statement.

### THERMOELECTRICITY AND GAS THEORY.

The splendid way in which the second law of thermodynamics was applied to the phenomena of thermoelectricity, so as to establish the laws of a thermoelectric circuit, is too well known to demand notice here. The chief features of it are to be found on p. 240 of Lord Kelvin's "Math. and Phys. Papers," vol. i.; but the enterprise was, I think, to some extent attended by good fortune, such as often rewards those who do not hesitate to risk something in the development of a theory, leaving it to be corrected, if necessary, by the future. (J. R. Mayer's theoretical estimate of J is another illustration.) It so happens that the thermoelectric theory has demanded very little correction, in spite of the intrinsic uncertainty attending application of the second law to an operation which had one irreversible feature about it—which might have been more relevant than it turns out to be—viz., heat conduction.

As an example of the opposite tendency, however, in Lord Kelvin's mind—for it was a mind which at times was extremely cautious—I think I may instance the difficulty he felt about the Boltzmann-Maxwell theory of the distribution of molecular energy. He always seemed to be troubled with a persistent difficulty about the innumerable degrees of freedom possessed by a molecule, and was unwilling to accept the position that many of these degrees of freedom were out of the running, so to speak—were beside the mark, for the purposes of gaseous theory, inasmuch as it was only those which affected, and were affected by, *collisions* that really mattered. Anything like organised motion, such as that of the planets, is out of the running, of course, and so is any internal motion of the parts of an atom which collisions do not produce or lessen or in any way affect.

It may be said that some collisions, like those which result in chemical combinations, do shake the parts of an atom—as is known by the emission of light. That is quite true, but then these collisions are exceptional, and, moreover, energy so transferred is speedily radiated away. The Boltzmann-Maxwell theory only applies to that which remains a permanently constituent portion of the heat energy of the substance—that is to say, the energy effective in producing pressure and the other manifestations of temperature—the unorganised random collision energy; it is this alone which need ultimately distribute itself equally among the parameters, through the agency of innumerable encounters. It is probable, however, that Lord Kelvin would not concur in the simplicity of this statement; he continued to be impressed by outstanding difficulties.

### Dissipation of Energy.

Of Lord Kelvin's work in connection with the dissipation of energy I shall not say much. I fancy that he himself, and certainly some of his disciples, have been at times inclined to attribute to the law of degradation more ultimate and cosmic importance than properly belongs to it. Its significance is limited to the validity of the terms "heat" and "temperature"; and if for any reason those terms cease to have a practical meaning, then the dissipation of energy also ceases to be inevitable. The theory, as originally stated by its author, was formulated as an axiom beginning, "It is impossible by means of inanimate material agency," &c., which at once conveys a suggestion that by some other means it may be possible. The different availabilities of energy of various kinds must be essentially a human and temporary conception, useful and convenient for practical purposes, but not ultimate or cosmic. What devices there are for thrusting aside the inevitableness of dissipation, and so evading the goal of ultimate stagnation, I do not know; they have not yet been discovered by us; but there is nothing inconceivable about them. Maxwell's "demons" is one attempt in that direction; nitrifying bacteria have been suggested as another. It is not at all certain what the influence of "life" may be; and all these agencies have to be eliminated if the uncompromising dissipation of energy doctrine is to be accepted. It was not originally stated in quite uncompromising form (see p. 514 of vol. i.).

The *conservation* of energy is a very different thing: that applies to every form, and is a comprehensive law; but the dissipation of energy has no meaning in circumstances when "heat" and "temperature" are obsolete terms,—that is to say, when what we now consider to be unorganised and intractable molecular motions can be dealt with in an individual and organised way. Ultimately and absolutely no operation need be irreversible. Irreversibility means only that things have got temporarily beyond our control, as a fire does sometimes.

### Absolute Measurement.

To Lord Kelvin, more than to anyone else, we owe the realisation of the system of absolute measurement applied to such intractable quantities as are found in electricity and magnetism; and if the world decides to call its commercial electrical energy unit—now commonly spoken of, in insular fashion, as a Board of Trade unit, or B.T.U.—by the universally known and appreciated name of "a Kelvin," such a procedure will be entirely appropriate.

Counting, or the enumeration of discrete quantities, is a very easy and natural operation; but measurement, in the sense of expressing the warmth of a day, or the brightness of a light, or the strength of a current, or the field of a magnet, or the resistance of a wire, or the transparency of a window, or the elasticity of a metal, or the conducting power of a gas, in numerical fashion, is not by any means a simple thing; it usually needs great ingenuity, and sometimes can hardly be done.

The invention of suitable units, and the mode of expressing currents and electromotive forces and resistances in such units, is very far from being an obvious notion; and even now the full meaning of the idea of absolute measurement is not in all quarters quite clear. In the first instance it was not always quite clear, I venture to say, even in the mind of Lord Kelvin himself; and a certain partial incompleteness was almost necessary in order to reduce electric and magnetic quantities to simple mechanics. For, as a matter of fact, they cannot be reduced to simple mechanics, or, at least, have not yet been so reduced; and it was by partially blinding ourselves to that fact that the ideas of the ohm, the ampere, and the volt were attained. We used to be told that resistance was a velocity, and that electrostatic capacity was a length, also that self-induction was a length, and so on. But, of course, resistance is not a velocity, nor is self-induction or capacity a length. Nevertheless, had it not been for this partially erroneous simplification, the introduction of any system of electric measurement would probably have been seriously delayed. Incidentally, it may be noted that the magnetic method of measuring resistance, or "determining the ohm," was devised by Weber. Kelvin's first method was based upon Joule's law (see p. 502, vol. i.).

### Absolute Temperature.

One of the remarkable achievements of Lord Kelvin has been the conception and determination of absolute temperature. The idea of an absolute temperature—that is to say, of a temperature reckoned from a real and actual zero, not a conventional one, and specified so as to be independent of the properties of any particular substance—follows rather naturally from the second law of thermodynamics, and from the fact that the efficiency of a perfect or reversible heat engine is independent of the properties of the working substance being dependent only on the temperatures at which heat is supplied and withdrawn. Absolute temperature is, in fact, the reciprocal of Carnot's function, as Kelvin showed in 1848 (p. 100, vol. i., "Math. and Phys. Papers"). And the absolute zero is the temperature at which the working substance has exhausted all its heat in doing work, so that there is none to yield up as waste—the temperature, in fact, at which a condenser or "cold body" becomes unnecessary.

On a thermal diagram a *scale* of temperature can easily be drawn, as the rungs of a ladder between two adiabatic lines, such that the area of each space is the same; and in order to find the number of rungs, with a given-sized degree, it becomes a matter of experiment to determine the total heat obtainable from an isothermal operation performed on the substance to which the adiabatic lines belong. The measurement necessary can be made upon any substance—steam or anything else—but it must be dependent on an actual operation (say an expansion)—not a closed cycle of operations—and on a measurement of the change of energy therefrom resulting.

Lord Kelvin gives as the general expression for the absolute temperature of any substance whatever, the internal energy of which is E,

$$T = \left(p + \frac{dE}{dv}\right)\frac{dT}{dp} - \frac{dE}{dp} \cdot \frac{dT}{dv} \quad . \quad . \quad . \quad (A).^{1}$$

For an ordinary gas $\frac{dE}{dv} = K + c\frac{dT}{dv}$, where K is Laplace's cohesion constant; and $\frac{dE}{dp} = c\frac{dT}{dp}$; so this expression (A) agrees with what we obtain below as equation (5).

The actual determination, as hitherto experimentally made, of the zero of absolute temperature, below which it will be for ever impossible to cool bodies—since at that temperature they possess no heat, and, therefore, cannot have any more removed—may be said to depend (not necessarily or theoretically, but actually as the simplest method in practice) on the conception of a perfect gas in the first place;—that is, one of the molecules of which act upon each other and upon the surrounding walls solely by bombardment, there being no cohesion whatever between the molecules. The temperature at which the pressure of such a

[1] See "Encyclopædia Britannica," article "Heat."

gas becomes zero must be simply the temperature of absolute molecular rest, and, therefore, will be the absolute zero. From the properties of such a gas its absolute temperature could at once be experimentally determined, if only such a gas were available for experiment; for it would come out as the reciprocal of its coefficient of expansion. But as a perfect gas is not available, an imperfect gas has to be employed, and a correction made for the amount of its imperfection; the amount of this correction being deduced by reasoning based on its behaviour when subjected to an irreversible operation. For instance, it may be allowed suddenly to expand adiabatically in such a way as to do no external work, and, therefore, not to cool itself if it were perfect, provided time is allowed for all eddies and streaming motions to subside; and we may then observe the actual consumption of heat or fall of temperature really produced—which would be proportional to the cohesion multiplied by the change of volume. The change of temperature so observed is the chief term in a correction to be applied to the reciprocal of the observed coefficient-of-expansion-under-constant-volume of the imperfect gas.

The experiment as first made by Gay-Lussac, September, 1806, and later independently and more exactly by Joule, of allowing a gas to double its volume inside a closed vessel, by opening a connection between a full and an empty portion of a vessel, was manifestly an interesting and suggestive experiment, and a check or verification of Mayer's hypothesis that the mechanical equivalent of heat could be obtained by equating the heat supplied and the work extracted from expanding air; but the full meaning and bearing of such an experiment is by no means obvious, and it is remarkable that it should lead to a determination of the zero of absolute temperature. For this purpose it has to be repeated in a more refined form—the oozing of gas as a steady stream from high pressure to low through a porous plug—and a determination made of the change of temperature resulting, when all eddies and organised kinds of motion have subsided, and when everything has become heat again, except what was lost in internal work.

It is well known now that the practical liquefaction of gases depends on this very effect; for, of course, without some cohesion between the molecules liquefaction would be quite impossible. The essence of liquefaction is the automatic subdivision of the contents of a vessel into two sharply bounded regions of different density, and the retaining of them in this condition for a time by internal molecular forces.

### ABSOLUTE TEMPERATURE.

The elementary argument about the notion of absolute temperature in terms of a perfect gas can be put thus:—

A perfect gas is one the molecules of which act on each other, and on the walls of the containing vessel, solely by bombardment. Simple mechanics shows that such a substance exerts a pressure—

$$p=\frac{1}{3}\rho u^2 \; ; \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and whenever it expands all the work done is against external pressure.

The heat in such a body is solely the energy of its irregular or unorganised molecular motion—including rotation as well as translation; and the temperature of such a body can be defined as simply proportional to the heat, or equal to the heat divided by a capacity-constant $mc$.

If the gas has to expand against external pressure, more heat must be supplied to allow for the external work done, $\int p dv$; the capacity being now called $mc'$ if the pressure is constant. Consequently, if the gas be heated at constant pressure, from absolute zero up to the temperature T, the heat required can be expressed as—

$$\mathrm{H}=mc\mathrm{T}+pv=mc'\mathrm{T} \; ;$$

wherefore—

$$p=\rho(c'-c)\mathrm{T} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

which may be called the characteristic equation of the substance.

Comparing this with the first equation, we see that—

$$u^2=3(c'-c)\mathrm{T} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

which constitutes a definition of absolute temperature in terms of the characteristic constant $c'-c$; the "3" having reference to the three dimensions of space.

Actually to determine T we can employ equation (2), and can get rid of the constant, say, by measuring the increase of pressure when the gas is heated at constant volume. This gives—

$$\frac{dp}{p}=\frac{d\mathrm{T}}{\mathrm{T}};$$

or—

$$\mathrm{T}=p\frac{d\mathrm{T}}{dp}=\frac{1}{a} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

the reciprocal of the coefficient of expansion.

In other words, the expansibility of a perfect gas is simply the reciprocal of its absolute temperature.

This is consistent with the form of characteristic equation which allows for molecular bulk, though not for molecular forces—namely, $p(v-b)=\mathrm{R}\mathrm{T}$.

For a slightly imperfect gas there is the cohesion or molecular-attraction term to be attended to as well, and its characteristic equation is—

$$(p+\mathrm{K})(v-b)=\mathrm{R}\mathrm{T},$$

K being a function of volume only. For constant-volume warming this gives—

$$\frac{dp}{p+\mathrm{K}}=\frac{d\mathrm{T}}{\mathrm{T}},$$

or—

$$\mathrm{T}=p\frac{d\mathrm{T}}{dp}+\mathrm{K}\frac{d\mathrm{T}}{dp}$$

or—

$$\mathrm{T}=\frac{1}{a}\left(1+\frac{\mathrm{K}}{p}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where $a$ is the coefficient of expansion as measured on a constant-volume thermometer; showing that a correction factor not far from unity must be applied, depending on the incipient cohesion or inter-molecular attraction, represented by Laplace's K or van der Waals's $\mathrm{A}\rho^2$.

To get K we must perform a definite operation, say a sudden expansion $\delta v$, under adiabatic conditions, allowing no external work to be done; and we must observe the resulting absorption of heat, say by noticing the small change of temperature $\delta\mathrm{T}$. It would be zero if the gas were perfect. If imperfect, the energy lost is $\mathrm{K}\delta v$.

To ensure that no external work is done, the operation must be performed in a rigid vessel, and a steady stream of gas will carry off the defect of heat $\delta\mathrm{H}$. The cooling will then be due only to internal work $\mathrm{K}\delta v$; and the heat change can be expressed as $mc'\delta\mathrm{T}$, when eddies have subsided.

Thus we get—

$$\mathrm{K}\delta v=\delta\mathrm{H}=mc'\delta\mathrm{T}=v\rho c'\delta\mathrm{T} \; ;$$

but now instead of $\delta v$ we may write $-\frac{v}{p}\delta p$, since the temperature is nearly constant, so that—

$$\mathrm{K}=-\rho c' p\frac{\delta\mathrm{T}}{\delta p} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Hence, denoting by $\theta$ the small observed change of temperature corresponding to the change of pressure $\Pi$, and substituting (6) in equation (5), we get finally as an expression for the absolute temperature of the gas experimented on—

$$\mathrm{T}=\frac{1}{a}\left(1-c'\rho\frac{\theta}{\Pi}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Perhaps the equation looks still clearer if we write it in terms of the volume of air $v$ streaming through the porous plug, down the difference of pressure $\delta p$, and carrying with it ultimately the defect of heat $\delta\mathrm{H}$, measured anyhow; for then—

$$\mathrm{T}=\frac{1}{a}\left(1+\frac{\delta\mathrm{H}}{v\delta p}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad (7^1)$$

But the expression for the absolute expansion term—

$$aT = \frac{p+K}{p} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5^1)$$

is also a very simple one.

To interpret equation (7) numerically—

The quantity $c'\rho$ will be recognised as *the atomic heat*, which is nearly the same constant for all ordinary gases, and equal in c.g.s. energy units to—

$$0{\cdot}2375 \times 0{\cdot}001293 \times (42 \times 10^6) = 0{\cdot}001294 \times 10^6 \text{ ergs per c.c. for dry air.}$$

The actual change of temperature per atmosphere, observed as the final result of the irreversible Joule and Thomson expansion, was, for air, a lowering of about a fifth of a degree, or more exactly $0^\circ{\cdot}208$; so that—

$$\frac{\theta}{\Pi} = \frac{0{\cdot}208}{10^6 \text{ dynes per sq. cm.}}.$$

Hence, since *ergs per c.c.* are the same as *dynes per sq. cm.*, the value of what we have just reckoned as the dimensions of the whole term $c'\rho\theta/\Pi$ comes out right as a pure number (being plainly a ratio of two energies when $\rho$ is written $m/v$); and the correction factor for air equals—

$$1 + 0{\cdot}001294 \times 0{\cdot}208 = 1{\cdot}00027.$$

At zero Centigrade the expansibility of air was measured by Regnault as 0·0036706. Wherefore the absolute temperature corresponding to zero Centigrade is, in accordance with equation (7)—

$$\frac{1{\cdot}00027}{0{\cdot}0036706} = 273{\cdot}17.$$

### Electrical Theory of Matter.

On the great modern region of physics centring round an electrical theory of matter, Lord Kelvin's mind was somewhat conservative; as perhaps it was in electricity generally, whenever results could not be obtained by straightforward dynamics or by energy calculations. In other directions he only advanced under protest, as it were, towards the goal at which others were enthusiastically working. Nevertheless, we owe to him some pioneering work even in this branch.

Comparatively modern speculation and calculation on the structure of an atom are contained in a remarkable paper by Lord Kelvin, published in the *Phil. Mag.* for 1901 under the curious title "Æpinus Atomised." It is reproduced in the volume of Baltimore lectures as Appendix E. It was probably the first attempt to work out the statics of an atom, according to a simple conception the major consequences of which can be traced with comparative ease, viz., that of a spherical portion of uniform positive electricity in which minute negative charges are sown like specks; being attracted towards the centre of the sphere according to the law of direct distance, and repelling each other according to the inverse square law.

### Cosmic Calculations.

Of the work of Lord Kelvin in elasticity, I shall here say nothing beyond the remark that his kinetic view of elasticity often seems to me one of the most suggestive and ultimately pregnant of all his theories.

His papers on celestial dynamics are very remarkable and lucid, though we may not feel that they represent the last word on the question; any more than the last word has been said as to the age of the sun or of the earth. The fact that after a lifetime of immersion in all the intricacies of natural philosophy Lord Kelvin still postulated an origin or beginning for the material universe—a beginning when it was essentially different, not only locally but universally, from its present condition—and that he endeavoured to conceive what it might then have been like, in those early times—is a notable circumstance and one of general interest. To me there appears no reason for calling those times "early" rather than "late"; nor would I suppose a beginning or ending at all, either for space or for what is in space, other than such beginnings or endings as we might detect, or may hope to detect, somewhere, even now.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Prof. Wulfing has been appointed to the chair of mineralogy in the University of Heidelberg. We notice also that the same university has just celebrated the fiftieth anniversary of the doctorate of Prof. Georg Quincke, professor of physics in the University.

The correspondence between the Colonial Secretary (Mr. J. C. Smuts) and the council of the Transvaal University College relating to the organisation of higher education in the Transvaal has just been issued as a Blue-book (T.G.—24—1908). The question of a Transvaal university is not considered yet to be ripe, the proposals at present being for the establishment of a university college. If the recommendations of the committee appointed by the Colonial Secretary be carried out, the Transvaal University College will be a federation, under one council, of three institutes. The technical courses would be assigned to the Johannesburg branch, the literary and science courses to Pretoria, and the agricultural work would be centred at Frankenwald. It has been decided to proceed at once to carry out the scheme so far as it relates to the allocation of the various departments of work and study to the Pretoria and Johannesburg branches respectively. For the Frankenwald branch it is hoped that 200,000*l.* will be available from the Beit bequest, but this part of the scheme is deferred. Certain questions relating to the constitution of the reorganised college are also held in abeyance. It is obvious that the three branches will have but a slender bond of union; but after reading their report we are inclined to accept the view of the committee, that the difficulties in the way of finding any one place where the branches can be developed side by side are insurmountable.

The *British Medical Journal* for August 15 gives its readers a lengthy report of the discussion by the British Medical Association at Sheffield on the education of the medical student. The speakers included Profs. Starling, Armstrong, Sherrington, Sims Woodhead and Osler, Sir Felix Semon, Dr. Dawson Turner, Dr. Buist, and Dr. Russell Wells. The discussion formed part of the proceedings of the Section of Physiology, but the list of speakers guaranteed adequate handling of their theme in respect of scientific as well as clinical aim. It appeared to be widely held that (1) the period devoted to preliminary and intermediate study should be curtailed; (2) closer consideration should be paid during the intermediate course to the practical needs of the future medical man—*e.g.* biological studies should have a physiological rather than a morphological bias; (3) more clinical study is required in the later periods of the training, especially practice of diagnosis; (4) there should be fewer lectures and more demonstrations. The leading article in the same number of the journal is devoted to a consideration of this discussion jointly with the new regulations for the medical curriculum recently promulgated by the University of London. The journal approves the decision of the University to extend the final part of the curriculum to thirty-six months. We may point out that we are still behind the foremost Continental countries in our estimate of the time required to train a qualified medical practitioner.

A well printed and illustrated pamphlet has been issued by the British Education Section of the Franco-British Exhibition under the title "A Short History of National Education in Great Britain and Ireland." In the article which appeared in Nature for August 13 attention was given to the manner in which the exhibition, both as a whole and in detail, illustrates national progress, whether such progress be viewed from the pedagogic or from the administrative aspect. The booklet now before us deals with the latter aspect, and its author—Mr. T. L. Humberstone—gives a broad and clear outline of his subject. Too little is said of private schools, but the history of public provision for education during the last three centuries is made clear. The awakening of England and Wales during the last century to their responsibility for educating their citizens is traced with judgment, and mention is made of the latest development of this sense of responsibility shown by the medical inspection of school children. The value of this production is much in excess of its price—it is published by Messrs. King at 3*d*.

## SOCIETIES AND ACADEMIES.

### PARIS.

**Academy of Sciences**, August 17.—M. Bouquet de la Grye in the chair.—A problem relating to the theory of orthogonal systems and the method of the mobile trihedron: Gaston **Darboux**.—The detection of a particular class of rays which may be emitted by the sun: H. **Deslandres**. An attempt at an explanation of the phenomenon of the second twilight. M. Durand-Gréville has recently shown that this phenomenon is a general one, and is not confined to mountainous districts. If there are solar radiations of wave-length smaller than 0·1 $\mu$, possessing an index of refraction greater than the known rays, and for which the ratio $n-1/d$ ($n$ being the refractive index and $d$ the density of the gas) is five or six times greater than with the luminous rays, the sunset for these rays would be about fifteen minutes after the sunset visible to the eye. It is further supposed that these ultra-violet rays excite phosphorescence in the atmospheric particles. These hypotheses would account for the second twilight, but further proof of the existence of such ultra-violet rays is necessary.—A hailstorm which followed the path of a high-tension circuit: J. **Violle**. This destructive hailstorm moved about 14 kilometres, and had a width of about 2 kilometres. It was remarked that its direction coincided very exactly with that of a high-tension line (45,000 volts). Owing to the fact that the permission of the owners had to be obtained in fixing this line, its course was sinuous. The most serious damage was done in the immediate neighbourhood of the wire, decreasing to the right and left, and ceasing altogether at about 800 metres to 1000 metres on each side. One of the owners of the district where the storm commenced was about 400 metres from the line, and observed three large spheres, twice as large as a man's head, which remained for a moment suspended, and the explosion of which was immediately followed by the fall of hail. These observations raise an interesting question as to the relation between these destructive hailstorms and lines transmitting electric energy under high voltage.—Periodic functions: P. **Cousin**.—The formation of fogs in presence of the radium emanation: Mme. **Curie**. The production of a mist in moist gases by the action of the radium emanation has been pointed out in an earlier communication. In the present paper an attempt is made to trace the cause of this phenomenon. It appears to be due to a chemical reaction under the influence of the emanation. In some cases the nature of the products has been determined with certainty; with carbon dioxide a little carbon monoxide is produced; air gives some oxides of nitrogen; sulphur and air produce traces of sulphurous and sulphuric acids. The mists produced are composed of very minute drops, not electrically charged.—Anatomical researches on the vegetative apparatus of the Geraniaceæ: Abel **Legault**.—The origin of the colour of black grapes: Philippe **Malvezin**. An account of the production of the red colour in grapes picked before the colour had developed. The results are in accord with the view of Duclaux, that there is only one chromogenic material in the grape, the transformation of which takes place under the simultaneous influence of air, heat, and possibly light.—The radio-activity of certain springs producing goitre: M. **Répin**. Various theories have been proposed to account for the production of goitre by certain waters. Two of these, the presence of a distinctive micro-organism or the presence of a rare mineral element, are regarded by the author as untenable from his researches. One singular property of such waters has been known for some time—the power of producing goitre disappears spontaneously after a certain lapse of time. This appeared to resemble the disappearance of radio-activity in certain mineral waters, and the author has examined several springs, well known to have the property of causing goitre, from this point of view. Three such springs were examined, and all were found to be radio-active, the one possessing the greatest radio-activity also being the one best known for its goitre-producing properties. There would thus appear to be a distinct parallelism between the two phenomena, and further work is being carried on from this point of view.—The optical properties of some contractile elements: Mlle. Doris L. **Mackinnon** and Fred. **Vles**. The contractile elements appear to form two groups from the point of view of their reaction between crossed Nicols; in the one the lighting is due to double refraction (muscular elements in general), in the other the lighting is due to depolarisation (cilia).—The changes in the nuclei of the lecithogenic cells of Rhabdocœles: Paul **Hallez**.—The persistence of the pronephros in Teleostea: Frédéric **Guitel**.—The fossil flora of Lugarde, Cantal: P. **Marty**.

### CALCUTTA.

**Asiatic Society of Bengal**, August 5.—Major James Rennell's journals, 1764–7: T. H. D. **La Touche**. These are the original journals written by Major James Rennell, the first Surveyor-General of India, during his surveys of the rivers of Bengal, including an expedition up the Brahmaputra to the frontiers of Assam. They cover the period from 1764 to 1767, when Lord Clive was Governor of Bengal. Daily observations on the weather are given, and determinations of the variation of the magnetic needle at various places.—The Kosi River, and some lessons to be learnt from it: Captain F. C. **Hirst**. This paper gives an account of the past history of the Kosi River, its present condition, and of the considerations which, in the author's opinion, should govern any attempts made to control the river by embankments or otherwise.—A general theory of osculating conics (second paper): Prof. Syamadas **Mukhopadhyaya**.—Memoir on the surgical instruments of the Hindus, with a comparative study of the surgical instruments of the Greek, Roman, Arab, and modern European surgeons, part iii., the sharp instruments: Girindranath **Mukhopadhyaya**.

## CONTENTS.

THURSDAY, SEPTEMBER 3, 1908.

## MARINE DEPOSITS.

*Les Dépôts marins.* By Dr. Léon W. Collet. Pp. vii+325; with 35 figures in text and a map. (Paris: Octave Dion, 1908.) Price 5 francs.

THE publication of this volume is connected with the inauguration of a scientific work on the grandest scale. It is proposed to issue under the title of "Encyclopédie scientifique" about 1000 volumes in the French language, dealing with every branch of pure and applied science. The general director of this vast work is Dr. Toulouse, and its general secretary M. H. Pieron; but for each of the branches of science, to the number of forty, an editor specially conversant with the subject has been secured.

The volume before us is the first published of the group of works on "Océanographie physique," the editor of which is Dr. Jules Richard, of the Musée Océanographique de Monaco. Dr. Collet, who is a privat-docent in the University of Geneva, had the advantage of spending two years of study in the *Challenger* Office in Edinburgh, and the volume is appropriately dedicated to Sir John Murray. The work is professedly based on Murray and Renard's well-known *Challenger* volume, though a considerable amount of information obtained by later researches is incorporated by the author. The illustrations are taken either from the *Challenger* Report, from Dr. J. M. Flint's Bulletin on the Oceanography of the Pacific, from the Encyclopædia Britannica, or from the papers published by the author and Dr. Lee on glauconite deposits.

The book commences with a slight sketch of the work done in the subject before the despatch of the *Challenger* Expedition, and an essay on the effects of temperature in determining the distribution of plants and animals at the surface and in the deeper parts of the ocean. The classification adopted for the various deposits is that of Sir John Murray, with some slight and unimportant modifications, though the author notices the attempt of Thoulet to substitute for this grouping one on a mathematical basis—the size and chemical composition of the particles of which the deposits are built up being taken as a guide.

While the accounts of the several oozes and of the manganese nodules and other materials found in the red muds are condensed from the descriptions in the *Challenger* volume, the chapter on the glauconite deposits extends to much greater length (48 pages), and is taken, with its illustrations, from the paper published by the author and Dr. Lee in the Proceedings of the Royal Society of Edinburgh.

The fourth division of the book, dealing with the deposits of coral-origin, extends to considerable length, and includes references to recent works, such as the Funafuti Report of the Royal Society, and the results of Mr. Stanley Gardiner's work in the Indian Ocean. The author adopts the estimate of the last-mentioned naturalist as to the limit of depth of coral-reef building organisms—namely, 64 metres for corals and 120 metres for "nullipores." In discussing theoretical conclusions from the known facts concerning coral-reefs, however, the author seems to be labouring under some unfortunate misconceptions. He says:—

"Le sondage de l'atoll de Funafuti dans les iles de l'Ellice fut entrepris aux fins d'obtenir des renseignements sur le soubassement d'une ile corallienne; bien que ce but n'ait pas été atteint, ce sondage n'en est pas moins très important, comme nous le verrons dans la suit" (pp. 261, 262).

It cannot, however, be sufficiently understood and remembered that the Coral-Reef Committee of the Royal Society was formed, not to seek for confirmation of any particular theory, but to obtain facts which might enable us to put the several theories to a critical test, and in this it was entirely successful. The committee included the advocates of all the different theories, and the plan and details of the expedition were agreed upon by mutual arrangement. The selection of Funafuti—as the most typical of atolls—was made by the late Admiral Sir W. Wharton (who was not a believer in Darwin's theory), and was accepted by every member of the committee. It was agreed by all that a boring of 1000 feet would be sufficient to test the several theories, even on the most liberal estimate of the depth at which reef-forming corals, &c., could flourish. The actual depth reached was 1114 feet, and the very careful study of the materials brought up was shown by Dr. Hinde to demonstrate, beyond doubt, that—setting aside subsequent chemical changes—the rock, *from top to bottom*, consists of the same organisms, in the same conditions as respects position of growth and association. Neither in the microscopical characters of the rock nor in its chemical composition was there the smallest indication in the lowest cores brought up of any volcanic, or, indeed, of any non-calcareous rock being approached. It was open, of course, to the opponents of Darwin's views to oppose the undertaking of the boring as an adequate test. But it is scarcely fair, now that the test has been applied under their own auspices, to declare that it is of no value.

The author reproduces an attempted explanation, with modifications by later authors, of the facts ascertained at Funafuti. But it must be remembered that these are new views, put forward *since* the boring was brought to such a successful termination by the skill and energy of Profs. Sollas and David and their assistants. Neither the theory of a talus nor the amended suggestion of the building up of the lower part of the atoll by the growth *in situ* of deep-sea corals, nullipores, or other organisms, receives the smallest support from the study of the cores brought up. Every unprejudiced observer of the whole course this discussion has taken must be convinced that the Funafuti boring, far from having failed in its object, was carried to a successful and useful conclusion.

In the final division of the work the author discusses some of the geological formations in the light of the results obtained by deep-sea explorations. In these he generally follows and summarises the work of M. Cayeux. In his discussion of the origin of the oolites, he makes no reference to the interesting recent researches of Mr. Wethered, nor to the early observations of De la Beche. The account of rocks formed by siliceous organisms is equally defective in many respects, and the papers of Dr. Hinde are not referred to either in the text or in the "Index Bibliographique" at the end of the volume.

Taken as a whole, therefore, the work, while it may be regarded as a very useful summary of the general results obtained, up to the present time, in the study of the ocean-floor by deep soundings, cannot be commended as an absolutely safe guide to those anxious to make their acquaintance with all the original sources of information on the subject.

## *THE CONTRAST BETWEEN GERMAN AND ENGLISH EDUCATION.*[1]

*German Education, Past and Present.* By Prof. Friedrich Paulsen. English translation by Dr. T. Lorenz. Pp. xx+310. (London: T. Fisher Unwin, 1908.) Price 5s. net.

To write well a short book on a vast subject is a task which only a master can accomplish. It is not too much to say that Prof. Paulsen is the only man in Europe who could have given, within such small compass, so readable and well-proportioned an account of the growth of German education from a remote past to the present time. Dr. Paulsen has style as well as profound knowledge. He knows what to leave out. He neither fatigues the reader by a superfluity of uninterpreted facts nor offends him by superficiality of treatment. Two years ago Messrs. Teubner, of Leipzig, published the original edition of this work in a slim, closely printed volume of less than 200 pages as one of the series which they are issuing under the title "Aus Natur und Geisteswelt." Now Mr. Unwin gives us the book pithily and idiomatically translated by Dr. Lorenz, and prefaced by a useful outline of the mechanics of the German educational system, and a short dictionary of English renderings of German technical terms. As it stands, it is the handiest book on the outlines of the subject in the English language.

For an English reader the weakest point in the book lies in the fact that Dr. Paulsen knows comparatively little about the history of education in England. This is not his fault. The history of English education—that most elusive, intricate, and many-provinced subject has not yet been satisfactorily written. Piece by piece, the materials for it are being brought together by scholars like Mr. Arthur Leach, Dr. Rashdall, Prof. Foster Watson, Mr. J. E. G. de Montmorency, and Mr. Sidney Webb. But the facts are not yet known with anything like completeness as regards some critical periods in the history of our English schools. The time for synthesis and illuminating generalisation has not come. We ourselves suffer from this at every turn. Pamphleteers give us what they believe to be the meaning of our educational history, and often mislead us as completely as might a guide with a bad map. But, apart from Mr. Graham Balfour's invaluable summary of facts in his "Educational Systems of Great Britain and Ireland," there is at present no book about higher education in the United Kingdom to which a student can turn as he turns to Dr. Paulsen's "Geschichte des gelehrten Unterrichts auf den deutschen Schulen und Universitäten," to the translation of which, by the way, Dr. Lorenz may perhaps feel willing to turn his hand. The result of this gap on the student's bookshelf is that even Dr. Paulsen, in spite of the extraordinary range of his knowledge of educational developments, fails to see the significance of the sidelights which German educational history throws upon English, and which, in its turn, English educational history throws upon German.

To the practical Englishman the main question which arises in the perusal of a book like this is "What have we to learn from the history of German education? What pitfalls can the record of their experiments help us to avoid?" Now, broadly speaking, the English and German systems of education are at the present time moving in precisely opposite directions towards a point which lies somewhere in the wide space which now stretches between them. In other words, the study of German education (using that term in a broad sense) is for an Englishman a study in contrasts. Germany (again using that term with due regard to the fact that one part is as different from another as Scotland is from England) has a great respect for intellect; we are a little on our guard against it. Germany believes in scientific research as applied to industry and commerce. We are only beginning not to be contemptuous of it. Germany is fast extending the age of compulsory education through the critical years of (at any rate male) adolescence. In England and Wales, out of the half-million children who annually leave the public elementary schools at thirteen or fourteen years of age, not more than one in three ever afterwards receives in point of civic or technical education any further systematic care.

So far the score is against us. But there is another side of the account. For real independence of private judgment the atmosphere of English life is much more favourable than the German. In the healthy development of the character of girls, the German schools have much to learn from the best English, and German secondary education can offer, except in schools which have broken loose from official routine, nothing really comparable to the training of the will which is afforded by the corporate life, where it is healthy and inspiring, of a first-rate English school.

The English reader of Dr. Paulsen's sketch, which, because it is drawn by a master-hand, shows the capital features of the situation in bolder outline than might a more detailed picture, cannot but note two points of significant difference in the educational history of the two countries. For generations education has been more thought of as a necessary State function in Germany than with us. But there was a time

[1] This review was written before the lamented death of Prof. Paulsen on August 15.

when the great body of Englishmen had as strong a sense as had their contemporary Germans of the propriety of some form of general State control over educational matters. Protector Somerset had it as strongly as Duke Christopher of Württemberg, Mulcaster as Melanchthon, Milton (when at last he grappled with the political aspects of the question) as Comenius, Archbishop Sheldon as the Great Elector. But at that point the parallel stops. In Germany thenceforth the idea of education as a function of Government waxes stronger; in England it is pushed into the background, only to come seriously to the front again in the Socialist movement led by Robert Owen in the first quarter of the nineteenth century. What is the cause of this divergence? The roots of the matter lie deep in the religious and political fortunes of the two countries. But the proximate cause of the difference may perhaps be found in the fact that the idea of the autocratic State (benevolent, educational, directive) found a congenial home in the German kingdoms, but in England an unfertile soil.

The other point which strikes the reader of Dr. Paulsen's masterly little book is that Germany is apt to give over-zealous adhesion to some idea or set of ideas which may be intellectually or politically fashionable at a given period, and then at a later time to change its mood and discard its old theory with a somewhat unrestrained contempt. Both for good and for evil, German educational development is scarred with deeper rifts than the English. Our growth has been more continuous but less enthusiastic; we have been readier to blend old-fashioned things with new; we have been less often carried off our feet by some favourite idea.

Now, as we look upon German education as a whole from our different standpoint, with respect and gratitude for all that German thought, German idealism, and German laboriousness have done for us, two features stand out in it as being of cardinal importance. The first is the influence exerted upon education, even upon some parts of university education, by the bureaucratically organised State. But is it, after all, a good thing to make a youth's future prospects of professional advancement depend so closely upon his performing the prescribed tasks of a prolonged school education, which is necessarily somewhat bookish and (in spite of all Matthew Arnold's too easy assurances) examination-clouded? The other point is that a belief in the supreme value of a "circle of ideas," built up in a boy's mind by the skilful hand of a schoolmaster, is much more deep-seated in Germany than in England. Education to them, far more than to us, means a highly trained and often eloquent teacher directing from his desk the aspirations and intelligence of rows of diligent and well-disciplined youths sitting before him, each with his neat satchel of books. Let us confess our fault. We have too faint an idea of personal obligation to the organised State. We have too little conception of the power of ideas. But does not the elaborately organised educational system of Germany tend to exalt too highly the prestige of the official and bureaucratic State? And does it not entrench in fortifications of vested interest a bookish and over-intellectualised kind of education, against the claims of which brilliant but not yet effective protest is made by Prof. Dewey in America and by Prof. Armstrong among ourselves?

M. E. Sadler.

## OUR BOOK SHELF.

*Industrial Electrical Measuring Instruments.* By Kenelm Edgcumbe. Pp. xiv+227. (London: A. Constable and Co., Ltd., 1908.) Price 8s. net.

Although, as the author points out in the preface, the subject of electrical measuring instruments is of great importance, there exists so far not a single work in the English language dealing comprehensively with such instruments. This book will therefore undoubtedly be welcomed by all engineers who have to deal with electrical measuring instruments, and by all who may chance to desire information as to the construction, working and maintenance of the various types of measuring instruments.

Every possible type of electrical measuring instrument, with the exception of supply meters, which has already been adequately dealt with in other books, is fully discussed from a practical point of view.

Although relays, synchronisers and lightning arresters cannot be classified as measuring instruments, they have been included, and this is certainly no disadvantage, as there is practically no information available about this class of apparatus except what is scattered in the technical papers.

The first thirty-nine pages are devoted to general principles, underlying all types of instruments, such as scales, control, pivots, springs, damping, &c., and contains much interesting information.

A good section is that dealing with resistance measurements, and a good description is given of the "Megger," one of the latest commercial instruments. The section on galvanometers is very short and contains very little information, and can in a future edition be enlarged with advantage. The various types of ammeters, voltmeters, and wattmeters are fully described, and the advantages and disadvantages compared. The section dealing with instrument transformers is specially useful, for there is little information available on this subject.

The section on recording instruments is not very complete; for instance, there is practically no description of any recording ammeter or voltmeter such as is used for traction work.

The last section, dealing with Prof. Fleming's cymometer and its application, might with advantage have been left out, first because the description given is only very brief, and secondly because it is entirely out of place in a book of this kind.

The book is clearly printed, and well illustrated by workmanlike sketches. The author, whose great practical experience in electrical measuring instruments is well known, has produced a most valuable book, containing a mine of practical information.

Many of the sections might in a future edition be somewhat enlarged and others cut out altogether, but this, of course, in no way diminishes the value of the book. It contains no misleading statements, is free from complicated mathematical formulæ, and can therefore be thoroughly recommended to all engineers who have to deal with this class of instruments. The subject of photometry is not touched upon; the author hopes to deal with this in another work.

L. C.

*The Deinhardt-Schlomann Series of Technical Dictionaries in Six Languages, German, English, French, Russian, Italian, Spanish.* By Kurt Deinhardt and Alfred Schlomann. Vol. iii., Steam Boilers, Steam Engines, Steam Turbines. Edited by Wilhelm Wagner. Pp. xi+1322; illustrated. (London: A. Constable and Co., Ltd., 1908.) Price 16*s*. net.

THE third volume of Deinhardt and Schlomann's illustrated technical dictionary cannot fail to prove of enormous value in international relations. The idea is quite original. The dictionary is in six languages, German, English, French, Russian, Italian and Spanish, and the necessity for elaborate definitions is obviated by the insertion of small sketches. The vocabularies are classified under the following heads:—A. Steam boilers: (1) fuels, (2) production of heat, (3) furnace installations, (4) transmission of heat, (5) evaporation, (6) testing of materials, (7) boiler construction, (8) types of boilers, (9) boiler fittings, (10) boiler erection, (11) feed apparatus, (12) steam superheaters, (13) management of steam boilers, (14) boiler explosions, (15) boiler inspection, (16) range of steam pipes. B. Steam engines: (17) theory, (18) machine parts, (19) condensers, (20) types of engine, (21) erection, (22) working of engines. C. Steam turbines: (23) theory, (24) steam-turbine parts, (25) turbine plant.

The volume concludes with an alphabetical index of the German, English, French, Italian and Spanish terms, showing the page and paragraph at which each word is to be found. A second index is devoted to the Russian words. The type is small but clear, and the volume is tastefully bound. Well-known experts all over the world have helped to revise the text, and the result is that Deinhardt and Schlomann's technical dictionary is undoubtedly the most accurate that has yet been published.

*Das Wetter und seine Bedeutung für das praktische Leben.* By Prof. Carl Kassner. Pp. vi+148; illustrated. (Leipzig: Quelle and Meyer, 1908.)

THIS book is No. 25 of the series "Wissenschaft und Bildung," edited by Dr. Paul Herre. It is published to meet the wish for information respecting the principles of weather prediction consequent upon the establishment of the public weather service in the German Empire (June, 1906). The Deutsche Seewarte, Hamburg, has issued an excellent daily weather report since February, 1876, for the whole of Germany, but the new system divides the Empire into fifteen forecast districts. The first section of Dr. Kassner's work deals with the historical development of weather prediction, and contains a concise summary of Dr. Hellmann's valuable researches into this subject, from the Babylonian era, some 4000 years B.C. This is a new departure from the usual course, and will be very useful for reference. Part ii. deals with the bases of modern weather prediction, with the preparation of weather charts, with areas of high and low barometric pressure, &c. This portion of the work, although not new, will be found most useful to students. The author has consulted all available sources of information, and presents a lucid exposition of the present state of the science; various popular notions, such as the supposed direct influence of the Gulf Stream and of the existence of icebergs on our weather (also lunar influence, part i.), are satisfactorily dealt with. Part iii. deals with the importance of weather in public and private life, and contains much that is not usually found in similar works.

## LETTERS TO THE EDITOR.

*[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.]*

### Indiscriminate Criticism.

MAY I enter a mild protest against a habit that seems to me somewhat harmful? Many people, when they obtain results which disagree with the previous work on the subject, seem to think it incumbent upon them to suggest that the disagreement comes from some flaw of reasoning or method in the work used for comparison.

This habit, especially in experimental work, where the chances against accuracy are always so great, is really a hindrance to the advancement of knowledge; "any stick is good enough to beat a dog with," and so the slight approximation to truth that there may be in the depreciated work will certainly not be enhanced by indiscriminate criticism, and may, thereby, be overlooked.

Surely it is understood that no one publishes results which disagree with those previously obtained without having a strong belief that his own work is, in one way or another, an advancement—why not, therefore, leave it at that? A saving of time and words would result.

I need scarcely say that I am not deprecating careful criticism; on the contrary, those who from facts and figures will point out where a source of error may lie confer a benefit on science. Unfortunately, people in the position to do this seem to shun the task.

What I have alluded to in the previous paragraphs may well be illustrated by examples drawn from criticism passed on researches lately published by Mr. Hartley and myself.

(1) Prof. Callendar (Proc. Roy. Soc., vol. lxxx., p. 466), when comparing our experimental results with an approximate calculation of his own, says, "the numbers in the last column appear to indicate a systematic error in the experimental numbers for strong solutions"; now it is possible, nay, probable, that there are systematic errors in the work, but it seems to me more would be done to elucidate the truth if he had either pointed out where the errors are or stated to what degree of accuracy his approximate calculation can be relied upon.

(2) Mr. O. F. Tower (Jour. Am. Ch. Soc., August, p. 1225) says, "Lord Berkeley and Mr. Hartley's results for the vapour pressures of the solutions are undoubtedly too low, showing probably that with their apparatus the air was not completely saturated," &c. This is a flagrant example; for Mr. Tower on the same page gives a table containing three sets of results, one obtained by Smits by a direct method, ours by an indirect one, and his own results, which are direct. Now Smits's numbers and ours, for the same concentration, give values (by different methods, be it noted) which are within 1 per cent. of each other, while Mr. Tower's numbers differ from the other two by nearly 10 per cent.!

As this letter is concerned with a more important matter than the accuracy of our work, I will not discuss Mr. Tower's assumption that the air was not saturated, &c.

(3) Messrs. Lincoln and Klein (Jour. Phys. Chem., xi., 1907) say,[1] when deducing the relative value of Prof. Kahlenburg's method of determining vapour pressures and ours, that Mr. Hartley and I claim an accuracy of 5 per cent. They omit, however, to state that our experimental error is (ultimately) calculated on the difference between the vapour pressures of solution and solvent, while theirs, if reduced to the same basis, would show errors of 25 per cent.

(4) Prof. Morse (Amer. Chem. Journ., vol. xxxiv., 1905, pp. 24–25) says, "we wish to speak of certain objections to a method of measuring osmotic pressures which has sometimes been practised. The attempt has been made, on several occasions, to ascertain the pressures of solutions by bringing mechanical pressure to bear upon the contents of the cell until," &c., and then goes on to raise purely imaginary objections to the method. It is interesting to

[1] Being away from home I am unable to give the exact wording.

note (*loc. cit.*, August) that Prof. Morse's latest corrected result (his own corrections) for the osmotic pressure at 0° C. of his 1·0 weight normal aqueous solution of cane sugar is 24·45 atmospheres, while ours, by the method under discussion, was 24·5 atmospheres.

Evian les Bains. BERKELEY.

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### The Rotation of a Crystal of Tourmaline by Plane Polarised Light.

(*Preliminary Note.*)

WHEN a beam of plane-polarised light is incident normally on a plate of tourmaline cut parallel to the optic axis, it will be absorbed or transmitted depending upon whether the axis of the tourmaline is parallel or perpendicular to the plane of polarisation of the incident light. If the arrangement is such that the light is absorbed, then in a given time a definite amount of heat energy will have passed from the source of light into the plate of tourmaline, and if, as is necessarily true, the former is at a high temperature while the latter is at a low temperature, it is plain that the entropy of the system will have been increased. The same increase in entropy would not have taken place if the orientation of the tourmaline had been such that the light had been transmitted.

Since the entropy of a system always tends to increase, it seemed to be of some interest to try what would happen if a plate of tourmaline was suspended so as to be free to rotate about an axis perpendicular to its faces, and then allowing a beam of plane-polarised light to fall on it in the direction of the axis of rotation, the arrangement being such that the plane of polarisation should make an angle of 45° with the optic axis of the tourmaline.

The experiment was tried by the author during the month of July, 1908, at the Rouss Physical Laboratory of the University of Virginia, and the results, though not absolutely conclusive, indicate that a moment acts on the tourmaline tending to set its optic axis parallel to the plane of polarisation of the incident light. In other words, the system tends to arrange itself so that as large a percentage of the light as possible shall be absorbed.

The apparatus used consisted of a fine plate of tourmaline, 1 cm. square, and 2·96 mm. thick, weighing almost exactly one gram. This was fastened to one end of a short straight copper wire to which was also fastened a small plane mirror. The system was suspended in a suitable vessel having a plane glass top and bottom, which could be exhausted, the suspension being such that the system had a period of 29·5 seconds. From the period and the moment of inertia of the system it was calculated that the moment necessary to give a deflection of 1 cm. with the scale at a distance of one metre was $2 \cdot 5 \times 10^{-5}$ dyne-cm. A beam of approximately parallel light from an arc was reflected in a vertical direction from a plane silver mirror, and was rendered plane polarised by a Nicol before entering the vessel.

Owing to the fact that the suspended system was not perfectly symmetrical with respect to its axis of rotation, it was found that the zero moved constantly in one direction when the light was allowed to fall on the tourmaline. This was undoubtedly due to radiometric action, and possibly also to the pressure of light. The motion was, however, much slower when the angle between the plane of polarisation and the optic axis of the crystal was +45° than when it was −45°. An average of twenty trials gave 150 seconds as the time to get a deflection of 30 cm. in the first case, while the time required for the same deflection when the angle was −45° was 90 seconds. These trials were all made with as high a vacuum in the vessel as could be obtained by means of the Gaede rotating mercury pump. The experiment was repeated at various pressures up to 10 or 15 cm. of mercury; the results were qualitatively the same, that is, the rate of deflection was much slower in every case when the angle mentioned above was +45° than when it was −45°, but the motion of the zero in one direction, although somewhat different at different pressures, could not be avoided.

If the cause of this motion of the zero is what was stated above, then it ought to disappear when the suspended system is made symmetrical about the axis of rotation.

These experiments were only preliminary, and during the coming winter a more careful investigation of the question will be carried out at the physical laboratory of the Johns Hopkins University. JOHN A. ANDERSON.

Physical Laboratory, Johns Hopkins University, August 15.

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### Access to Chemical Works.

STUDENTS of chemistry so often complain of the extreme difficulty of obtaining access to chemical works that it may be well to bear in mind that the universities and technical schools of the United Kingdom have perhaps a remedy for what is a serious obstacle to a proper study of chemistry. The amount of chemicals now consumed in educational laboratories must be enormous, and, as regards ordinary materials, quite sufficient to employ a large factory. A very large proportion comes from Germany. Let the universities start their own cooperative factory for the manufacture of the acids and salts they require. Let chemical students both have free access to it and put in part of their chemical course as workers there. The action of several universities in running their own farms for the benefit of agricultural students supplies a kind of precedent. When motives of education, patriotism, and economy point the same way, the scheme is worth consideration.

CHEMIST.

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## *FLY FEVER IN AFRICA.*

IN the *Times* of June 27 there appeared an article on "fly fever" in Africa, and the suggested destruction of big game. It appears that Prof. Koch has lately suggested that the African big game should be exterminated in order to destroy the principal means of nourishment of the tsetse fly. As this fly is the carrier of the infective agent of "fly fever," its extinction would, in Koch's opinion, blot out the disease. The members of the German Society for the Preservation of Game in East Africa are, naturally, opposing tooth and nail this proposed drastic measure of Prof. Koch. They deny the truth of his conclusions, and hold that the fly disease can exist where there is no big game, and, further, that there are other methods of getting rid of the fly without destroying the game.

This question is a complicated one, and perhaps if I give a short sketch of the history of the "tsetse-fly disease" I shall best clear the way to its better understanding.

When I went to Zululand in 1894 at the request of the Natal Government, to investigate an outbreak of nagana among native cattle, I was unaware that nagana and tsetse-fly disease were one and the same. Further, I believed, with the rest of the world, that the fly disease was caused by the poison of the tsetse fly, just as an animal is killed by the poison of a snake. Soon after arriving in Zululand a parasite, the *Trypanosoma brucei*, was discovered in the blood of the affected animals, and it soon became apparent that fly disease and nagana were one and the same. By suitable experiments it was demonstrated that this trypanosome is the cause of the disease. The next fact made out was that the trypanosome could be conveyed from sick to healthy animals by the local species of tsetse fly (*Glossina morsitans*). As this tsetse fly only remained infective for forty-eight hours, it was evident that it must get the parasite somewhere, and it seemed most probable that this would be from the wild animals living in the "fly country." This was found to be the case, and the *Trypanosoma brucei* was demonstrated in the blood of the buffalo, wildebeeste, koodoo, and other big game, both microscopically and by means of inoculation experiments.

Now this is a short summary of the discovery of the cause of the "tsetse-fly disease," and one point I want to bring out is that at that time, and for some time after, there was supposed to be only one "tsetse-fly disease" and one species of tsetse fly. The disease was called "the fly disease," and the fly "the tsetse fly." Now all this is changed, and "the fly disease" is now a generic term for several diseases, and the tsetse flies are found to be made up of several more or less well-marked species.

But the taking for granted that there was only one tsetse-fly disease of course led to much confusion and many mistakes. For example, when Koch studied the fly disease in German East Africa in 1898, naturally he considered he was dealing with the Zululand disease, nagana. But was he? Lately, I have studied a trypanosome from the East Coast which causes a more or less mild disease in horses and other animals. Is it not possible that Koch was dealing with this East Coast species when he said that Masai donkeys were not susceptible to nagana? So it can be easily understood how a great number of erroneous notions have crept into the literature of this subject.

It is evident that what is true of nagana, the disease caused by *Trypanosoma brucei*, need not be true of the diseases caused by *Trypanosoma theileri*, *dimorphon*, *pecaudi*, *congolense*, *vivax*, *nanum*, &c. But an observer comes in contact with one of these diseases in a place where there is no big game and no tsetse fly, and he at once thinks that "the fly disease" does not depend on big game or tsetse flies. When I say that "the tsetse fly" disappears from a district when the big game are killed off, and with the extinction of the big game that "the fly disease" also disappears, I only mean that *Glossina morsitans* disappears, and that a particular "fly disease"—that called by me nagana, and caused by *Trypanosoma brucei*—becomes extinct. I do not mean that the diseases caused by *Trypanosoma dimorphon*, &c., will be blotted out by the same means.

With the exception of nagana and sleeping sickness there is little real knowledge as to how the other African trypanosome diseases are spread. That they may spread by other agencies than tsetse flies is probable, since surra spreads in India, although there are no tsetse flies in that country. It is quite possible that many of these diseases in Central Africa may not be spread by the agency of tsetse flies and may not depend on the big game as a reservoir of the virus. The cattle themselves may be the reservoir, and the disease may be spread in the herd by means of any of the common biting flies, such as stomoxys or tabanus. In sleeping sickness, so far as we know, the native himself is the reservoir of the disease.

It is therefore, in my opinion, very important that, in the first place, these trypanosome diseases should be more thoroughly studied as to their distribution, their carrying agent, and the reservoir of the virus. When this is done it may well be that, by the use of this knowledge alone, owners of stock may escape damage. Now that we know the natural history of sleeping sickness, its distribution, its carrying agent, &c., any intelligent person has only himself to blame if he contracts it.

These few sentences will show how complicated a subject "the fly disease" has become, and in what a state of confusion and chaos the classification of this family of diseases at present is.

Lastly, in regard to the suggested destruction of big game. To begin with, it may be said that civilisation and big game cannot exist together. As soon as a new country is divided off into farms, either for agricultural or stock purposes, the great mass of the wild animals must go. Take, for example, the destruction of the fences by stampeding herds of zebra, wildebeeste, or buffalo, not to speak of the probability that there is not enough food to go round. Even in exceptional cases, where the wild animal has been protected from sentimental and picturesque reasons, as in the case of the herd of hippopotami preserved until lately in Natal, a time came when the neighbouring farmers could no longer put up with their destructive habits, and they had to be destroyed. We may say, then, that when a country becomes settled and civilised, the big game go. This has occurred in Cape Colony, the Orange River Colony, Transvaal, and Natal, and will occur in Zululand when that country is opened up.

But this inevitable disappearance of wild animals before the advance of civilisation is very different from the instant carrying into effect of an international measure for the wholesale destruction of big game all over Africa. Such a measure, in the present state of our knowledge, would be quite unjustifiable, and would probably fail to a great extent in its object. *Festina lente*. Let local authorities frame regulations from time to time as the exigencies of the place demand. But there ought to be room for the next thousand years in many parts of Africa for game reserves in which all the varieties of big game may live, thereby gladdening the eye and enriching the imagination and fancy of many future generations, and delaying the day when man will have for his sole companions the domestic hen, the cow, and the motor.

David Bruce.

## THE LATE HENRI BECQUEREL.

On Tuesday, August 25, 1908, died suddenly Antoine Henri Becquerel at Croisic, in Brittany, at the comparatively early age of fifty-six.

Henri Becquerel was the third of the scientific dynasty of that name. His grandfather, Antoine César Becquerel (1788–1878), a contemporary of Faraday, was a most prolific investigator of electrical and electrochemical phenomena. He was for forty-nine years a member of the Academy of Sciences, and from 1837 until 1878 professor of physics at the Musée d'Histoire naturelle in Paris. The second Becquerel, Alexandre Edmond (1820–1891), who is known chiefly for his researches in phosphorescence, which are embodied in the two volumes of his book "La Lumière," also made important investigations on thermo-electricity and on underground temperatures. He was professor at the Conservatoire des Arts et Métiers, and succeeded his father as professor and administrator of the Musée d'Histoire naturelle.

Into this distinguished family Henri Becquerel was born on December 15, 1852. He was educated first at the Lycée Louis le Grand, and at the age of twenty entered the École polytechnique. In 1875 he entered the service of the French Government as an Ingénieur des Ponts et Chaussées. Three years later, on the death of his grandfather, when his father succeeded to the full professorship at the Musée d'Histoire naturelle (the duties of which he had discharged for some years), young Becquerel was appointed his assistant under the title of "Aide-naturaliste."

Already Henri Becquerel had begun to show his powers in original research. The *Comptes rendus* for 1875 and 1876 contain his earliest papers, researches on magnetic rotatory polarisation. These were continued in 1876 in the *Journal de Physique*; while in a fourth memoir he discussed the effect on the phenomenon of using different wave-lengths. In 1878 he announced the discovery of the magnetic rotation of the plane of polarisation of light by the influence of the earth's magnetism. During the years from 1879 to 1883 he was associated with his father in a series of joint memoirs on the temperature at the surface of the earth, and beneath the surface to a depth of 36 metres, using thermoelectric methods for the subterranean observations. In 1879 he investigated the temporary magnetic properties of cobalt and nickel, and further examined the magneto-optic rotatory power of gases. He also determined the specific magnetic properties of ozone. Then he turned to the subject of phosphorescence, which his father had studied for so many years. One of the phenomena of phosphorescence—discovered originally by no other than Goethe—was the hastening of the fading out of the light of a phosphorescent body when exposed to the red rays at the hot end of the spectrum. Becquerel saw in this fact a means of studying the distribution of the intensity of the invisible infra-red rays of the spectrum. These cannot be photographed by ordinary photographic means. The method of exploring the infra-red spectrum by the thermometer or the thermopile is too coarse to give satisfactory results. The bolometer of Langley had not yet been invented. Becquerel exposed a brightly-phosphorescing strip of prepared material—one of the sulphides of the alkaline earths, so much studied by his father—to the action of the invisible infra-red spectrum, and found it to become striated with dark and light lines and bands, according as the radiation had hastened the decay of the luminosity. These phosphorographic studies he extended to include an investigation of emission spectra, in the same region, of incandescent metallic vapours. From 1886 to 1890 he was conducting experiments on the absorption of light in crystals, and on the anomalies in this absorption in different directions.

In 1892, on the death of Edmond Becquerel, Henri became professor in the Musée d'Histoire naturelle. In 1894 he was named Ingénieur en chef des Ponts et Chaussées, and in 1895 he was given a chair at the École polytechnique. Beyond giving an account of the laws of emission of light by phosphorescent bodies, he published little in these years. But in 1896 came the chief of his scientific successes. At the close of 1895 Röntgen had described the rays of peculiar penetrating power which he had observed to be emitted from highly exhausted Crookes's tubes, rays which he discovered and investigated by their singularly effective action in stimulating the luminescence of phosphorescible bodies. Associated as these rays were, both in the tubes whence they were emitted and on the platinocyanide screens where they were received, with the phenomena of phosphorescence, the association seemed to suggest a further inquiry. Was it not possible that in the phenomena of ordinary phosphorescence and fluorescence there might also be an emission of penetrating rays? Such a query suggested itself independently to several physicists in more than one country. Henri Becquerel was the first to publish any certain facts. In the *Comptes rendus* of February 24, 1896, there is a note by him, "Sur les Radiations émises par Phosphorescence." His experiment was as follows:—A photographic dry-plate was enclosed in opaque black paper. Over it was laid a thin plate formed of encrusted crystals of the double sulphate of uranium and potassium, and the whole was exposed to the sun for several hours. On developing the photographic plate it was found that the uranium salt (which has a brief phosphorescence) had emitted radiations capable of traversing the opaque paper and of reducing the silver salts. Metallic objects such as coins, interposed, left their silhouettes printed on the photographic plate. Such was the first announcement. On March 2 came a second note, "Sur les Radiations invisibles émises par les Corps phosphorescents." He has now found that the crystals of uranium salt produce the same effect when shielded from exposure to the sun's rays, and even when kept in darkness, and concludes that the invisible radiations emitted by phosphorescence continue to act long after the temporary phosphorescence has ceased. He recognises that here is a new order of phenomena. One week later he sends a third contribution. He has discovered that, like Röntgen's rays, the radiations emitted from the phosphorescent salts can discharge an electroscope, and he begins to employ this electric test quantitatively. He also announces that these new rays can be reflected, and possibly refracted. He tries different substances as to the amount and duration of their activity, finding the uranium salts to surpass by far the alkaline sulphides and the zinc-blende preparations. By March 23 he communicates another notice, in the title of which it is significant to observe that he has dropped all reference to phosphorescence. It is called "Sur les Radiations invisibles émises par les Sels d'Uranium"; for he finds that a non-phosphorescent solution of uranium is also active. He has also been studying the absorption of these rays, and has, he thinks, confirmed their refraction. On March 30 he reads to the academy another note on the differences between the radiations of uranium and the Röntgen rays. He insists that the former can not only be reflected and refracted, but that they can show double refraction and polarisation if transmitted through tourmaline. He has also obtained them from non-phosphorescing compounds of uranium. That he was mistaken in respect of reflection, refraction, and polarisation does not detract from the merits of the great discovery. Before six months from the date of his first note he was able further to announce that metallic uranium, furnished by his friend Moissan, far surpasses its salts in activity, the first example, he declares, of a metal presenting a phenomenon of the order of an invisible phosphorescence.

The subsequent development of the new branch of physics—radio-activity—thus opened out by the discovery of the Becquerel rays is known to all students of science. In 1898 Schmidt and Mme. Curie independently observed that thorium was also radio-active. M. and Mme. Curie set out on a systematic examination of other minerals, and Mme. Curie, after finding that certain uraniferous minerals were more active than uranium itself, embarked on the laborious search which yielded her the successive discoveries of polonium and radium. Rutherford, in the Cavendish Laboratory, repeated and extended Becquerel's measurements on the electrical properties of the uranium radiations, and pushed the investigation into new regions by demonstrating the various stages of phenomena explicable only on the hypothesis of the degradation of the uranium atom and the successive evolution of new elements of transitional types. Becquerel continued to investigate the radiations, and their divisibility into three kinds which differ in penetrating properties and in the deviations which they suffer when subjected to magnetic and electric forces. In 1903 he united in a large quarto memoir of 360 pages, under the title of "Recherches sur une Propriété nouvelle de la Matière," his hitherto scattered contributions. This memoir, written with admirable lucidity of phrase and illustrated with many plates, remains a witness to his powers of investigation and scientific acumen. He had since 1889 been a Membre de l'Académie des Sciences; he was also Officier de la Légion d'Honneur; and with the reputation of his great discovery honours fell thickly upon him. He was president of the Société Française de Physique in 1897. In 1900 the Royal Society awarded him the Rumford medal. In 1903 the Nobel prize in physics was awarded to him conjointly with the Curies. In 1907 the National Academy of the United States decreed to him the Burnard medal. In 1907 he was president of the Société nationale d'Agriculture, and the Berlin Academy awarded him the Helmholtz medal. In the same year he was elected vice-president of the French Academy of Sciences, and only in June last he was elected perpetual secretary of the Academy in succession to M. Lapparent. He was a member of many foreign academies, and received honorary doctorates from the Universities of Cambridge, Oxford, Aberdeen, Manchester, and Göttingen. He was a foreign fellow of the Physical Society of London, and an honorary member of the Royal Institution, where, in March, 1902, he lectured on radio-activity. In NATURE of December 22, 1905 vol. lxxi., p. 177), in an article of the series Some Scientific Centres, by Mr. J. B. Burke, an account is given of the laboratory of the Musée d'Histoire naturelle, illustrated by a portrait of Becquerel amongst the apparatus used in his researches. Amiable and ever courteous, he was greatly endeared to all who knew him by his frank and sympathetic demeanour. He leaves one son, M. Jean Becquerel, Ingénieur des Ponts et Chaussées, who has already distinguished himself by important investigations on the absorption of light in crystals and other researches, the latest of which promises to elucidate the nature of positive electricity. He has honourably carried on the family tradition even in having been appointed assistant in the Musée d'Histoire naturelle.

## *THE DUBLIN MEETING OF THE BRITISH ASSOCIATION.*

THE seventy-eighth annual meeting of the British Association for the Advancement of Science began yesterday, September 2, when Mr. Francis Darwin, M.A., LL.D., F.R.S., assumed the presidency and delivered his presidential address in the great hall of the Royal University of Ireland, Earlsfort Terrace, Dublin. More than 2000 members and associates are attending the meeting. In the afternoon of the same day the members met informally at the Dublin Mansion House, where the Lord Mayor, Alderman Gerald O'Reilly, bade them welcome in the name of the city.

The sectional meetings began this morning. They are mostly being held in the various schools of Trinity College, the sole college of Dublin University, which was founded some 300 years ago by Queen Elizabeth. The Educational Science Section meets in the Royal University building, which is shortly to be re-modelled for the accommodation of the new and as yet unnamed university founded by Mr. Birrell's recent Act. Other sections meet in the Royal Irish Academy, the Royal College of Science for Ireland (soon to be provided with new and handsome buildings), the historic Leinster House of the Royal Dublin Society, and the Royal Colleges of Physicians and Surgeons. A service of trams and a volunteer service of motor-cars have been arranged to facilitate the circulation of members among the various sections. The official journal, published every morning at 10, gives a list of papers to be read, and an intersectional telephone service announces the progress made with the reading of the various papers.

The examination hall in Trinity College has been fitted up as a reception-room, with the usual facilities as to postal and telegraphic business. Letters should be addressed to "British Association, Dublin." The names of persons for whom telegrams have been received are written on a blackboard at the post office. There is a liberal provision of writing, smoking, and lounge rooms, and drawing-rooms for ladies. There is an official luncheon-room in the dining hall of Trinity College, and luncheons and teas are obtainable in a marquee in the College Park.

The Royal Dublin Society and the Dublin Chamber of Commerce are offering the use of their rooms to members of the Association, and many of the clubs are giving facilities for temporary membership.

The "Handbook" to the city of Dublin and the surrounding district, prepared for the meeting and printed at the Dublin University Press, is an attractive work the production of which is creditable to the general editors, Prof. Grenville Cole and Mr. Lloyd Praeger. It contains 440 pages, numerous illustrations, and an excellent district map. Its contents deal with the geology, meteorology, botany, and zoology (the latter very fully) of the Dublin district. The history and archæology of Dublin are treated by a subcommittee of experts. A melancholy interest attaches to the sketch of the history of Dublin, by Mr. C. Litton Falkiner, late secretary to the council of the Royal Irish Academy, who lost his life mountain-climbing in Switzerland last month. A special chapter, edited by Prof. G. H. Carpenter, deals with the various scientific and other educational institutions of Dublin, and Prof. Adeney's work on Dublin industries and commerce concludes the volume, which will do much to bring the more exceptional features of the Irish capital before the scientific public in an informing and attractive manner.

E. E. FOURNIER.

### INAUGURAL ADDRESS BY FRANCIS DARWIN, M.A., PH.D., LL.D., F.R.S., PRESIDENT OF THE ASSOCIATION.

BEFORE entering on the subject of my Address, I may be allowed to refer to the loss which the British Association has sustained in the death of Lord Kelvin. He joined the Association in 1847, and had been for more than fifty years a familiar figure at our meetings. This is not the occasion to speak of his work in the world or of what he was to his friends, but rather of his influence on those who were personally unknown to him. It seems to me characteristic of him that something of his vigour and of his personal charm was felt far beyond the circle of his intimate associates, and many men and women who never exchanged a word with Lord Kelvin, and are in outer darkness as to his researches, will miss his genial presence and feel themselves the poorer to-day. By the death of Sir John Evans the Association is deprived of another faithful friend. He presided at Toronto in 1897, and since he joined the Association in 1861 had been a regular attendant at our meetings. The absence of his cheerful personality and the loss of his wise counsels will be widely felt.

May I be permitted one other digression before I come to my subject? There has not been a Botanical President of the British Association since the Norwich meeting forty years ago, when Sir Joseph Hooker was in the chair, and in "eloquent and felicitous words" (to quote my father's letter) spoke in defence of the doctrine of evolution. I am sure that every member of this Association will be glad to be reminded that Sir Joseph Hooker is, happily, still working at the subject that his lifelong labours have so greatly advanced, and of which he has long been recognised as the honoured chief and leader.

You will perhaps expect me to give a retrospect of the progress of evolution during the fifty years that have elapsed since July 1, 1858, when the doctrine of the origin of species by means of natural selection was made known to the world in the words of Mr. Darwin and Mr. Wallace.

This would be a gigantic task, for which I am quite unfitted. It seems to me, moreover, that the first duty of your President is to speak on matters to which his own researches have contributed. My work—such as it is—deals with the movements of plants, and it is with this subject that I shall begin. I want to give you a general idea of how the changes going on in the environment act as stimuli and compel plants to execute certain movements. Then I shall show that what is true of those temporary changes of shape we describe as movements is also true of the permanent alterations known as morphological.

I shall insist that, if the study of movement includes the problem of stimulus and reaction, morphological change must be investigated from the same point of view. In fact, that these two departments of inquiry must be classed together, and this, as we shall see, has some important results—namely, that the dim beginnings of habit or unconscious memory that we find in the movements of plants and animals must find a place in morphology; and inasmuch as a striking instance of correlated morphological changes is to be found in the development of the adult from the ovum, I shall take this ontogenetic series and attempt to show you that here also something equivalent to memory or habit reigns.

Many attempts have been made to connect in this way the phenomena of memory and inheritance, and I shall ask you to listen to one more such attempt, even though I am forced to appear as a champion of what some of you consider a lost cause—the doctrine of the inheritance of acquired characters.

### *Movement.*

In his book on "The Power of Movement in Plants" (1880)[1] my father wrote that "it is impossible not to be struck with the resemblance between the foregoing movements of plants and many of the actions performed unconsciously by the lower animals." In the previous year Sachs[2] had in like manner directed attention to the essential resemblance between the irritability of plants and animals. I give these statements first because of their simplicity and directness; but it must not be forgotten that before this Pfeffer[3] had begun to lay down the principles of what is now known as *Reizphysiologie*, or the physiology of stimulus, for which he and his pupils have done so much.

The words of Darwin which I have quoted afford an example of the way in which science returns to the obvious. Here we find revived, in a rational form, the point of view of the child or of the writer of fairy stories. We do not go so far as the child; we know that flowers do not talk or walk; but the fact that plants must be classed with animals as regards their manner of reaction to stimuli has now become almost a commonplace of physiology. And inasmuch as we ourselves are animals, this conception gives us a certain insight into the reactions of plants which we should not otherwise possess. This is, I allow, a very dangerous tendency, leading to anthropomorphism, one of the seven deadly sins of science. Nevertheless, it is one that must be used unless the great mass of knowledge accumulated by psychologists is to be forbidden ground to the physiologist.

Jennings[4] has admirably expressed the point of view from which we ought to deal with the behaviour of the simpler organisms. He points out that we must study their movements in a strictly objective manner: that the same point of view must be applied to man, and that any resemblances between the two sets of phenomena are not only an allowable but a necessary aid to research.

What, then, are the essential characters of stimuli and of the reactions which they call forth in living organisms? Pfeffer has stated this in the most objective way. An organism is a machine which can be set going by touching a spring or trigger of some kind; a machine in which energy can be set free by some kind of releasing mechanism. Here we have a model of at least some of the features of reaction to stimulation.

[1] P. 571.
[2] *Arbeiten*, ii. 1879, p. 282.
[3] *Osmotische Untersuchungen*. 1877, p. 202.
[4] "The Behaviour of the Lower Organisms," 1904, p. 124.

The energy of the cause is generally out of all proportion to the effect, *i.e.*, a small stimulus produces a big reaction. The specific character of the result depends on the structure of the machine rather than on the character of the stimulus. The trigger of a gun may be pulled in a variety of different ways without affecting the character of the explosion. Just in the same way a plant may be made to curve by altering its angle to the vertical, by lateral illumination, by chemical agency, and so forth; the curvature is of the same nature in all cases, the release-action differs. One of those chains of wooden bricks in which each knocks over the next may be set in action by a touch, by throwing a ball, by an erring dog, in short by anything that upsets the equilibrium of brick No. 1; but the really important part of the game, the way in which the wave of falling bricks passes like a prairie fire round a group of Noah's Ark animals, or by a bridge over its own dead body and returns to the starting-point, &c.—these are the result of the magnificent structure of the thing as a whole, and the upset of brick No. 1 seems a small thing in comparison.

For myself I see no reason why the term *stimulus* should not be used in relation to the action of mechanisms in general; but by a convention which it is well to respect, *stimulation* is confined to the protoplasmic machinery of living organisms.

The want of proportion between the stimulus and the reply, or, as it has been expressed, the unexpectedness of the result of a given stimulus, is a striking feature in the phenomena of reaction. That this should be so need not surprise us. We can, as a rule, only know the stimulus and the response, while the intermediate processes of the mechanism are hidden in the secret life of protoplasm. We might, however, have guessed that big changes would result from small stimuli, since it is clear that the success of an organism in the world must depend partly at least on its being highly sensitive to changes in its surroundings. This is the adaptive side of the fundamental fact that living protoplasm is a highly unstable body. Here I may say one word about the adaptation as treated in the "Origin of Species." It is the present fashion to minimise or deny altogether the importance of natural selection. I do not propose to enter into this subject; I am convinced that the inherent strength of the doctrine will insure its final victory over the present anti-Darwinian stream of criticism. From the Darwinian point of view it would be a remarkable fact if the reactions of organisms to natural stimuli were not adaptive. That they should be so, as they undoubtedly are, is not surprising. But just now I only direct attention to the adaptive character of reactions from a descriptive point of view.

Hitherto I have implied the existence of a general character in stimulation without actually naming it; I mean the indirectness of the result. This is the point of view of Dutrochet, who in 1824 said that the environment suggests but does not directly cause the reaction. It is not easy to make clear in a few words the conception of indirectness. Pfeffer[1] employs the word *induction*, and holds that external stimuli act by producing internal change, such changes being the link between stimulus and reaction. It may seem, at first sight, that we do not gain much by this supposition; but since these changes may be more or less enduring, we gain at least the conception of *after effect* as a quality of stimulation. What are known as *spontaneous* actions must be considered as due to internal changes of unknown origin.

It may be said that in speaking of the "indirectness" of the response to stimuli we are merely expressing in other words the conception of release-action; that the explosion of a machine is an indirect reply to the touch on the trigger. This is doubtless true, but we possibly lose something if we attempt to compress the whole problem into the truism that the organism behaves as it does because it has a certain structure. The quality of indirectness is far more characteristic of an organism than of a machine, and to keep it in mind is more illuminating than a slavish adherence to the analogy of a machine. The reaction of an organism depends on its past history; but, it may be

[1] "Physiology," Engl. edit., i. p. 11.

answered, this is also true of a machine the action of which depends on how it was made, and in a less degree on the treatment it has received during use. But in living things this last feature in behaviour is far more striking, and in the higher organisms past experience is all-important in deciding the response to stimulus. The organism is a plastic machine profoundly affected in structure by its own action, and the unknown process intervening between stimulus and reaction (on which the indirectness of the response depends) must have the fullest value allowed it as a characteristic of living creatures.

For the zoological side of biology a view similar to that of Pfeffer has been clearly stated by Jennings[1] in his admirable studies on the behaviour of infusoria, rotifers, &c. He advances strong arguments against the theories of Loeb and others, according to which the stimulus acts directly on the organs of movement; a point of view which was formerly held by botanists, but has since given place to the conception of the stimulation acting on the organism as a whole. Unfortunately for botanists these movements are by the zoologists called *tropisms*, and are thus liable to be confused with the geotropism, heliotropism, &c., of plants: to these movements, which are not considered by botanists to be due to direct action of stimuli, Loeb's assumptions do not seem to be applicable.

Jennings's position is that we must take into consideration what he calls "physiological state, *i.e.*, 'the varying internal physiological conditions of the organism, as distinguished from permanent anatomical conditions.'" Though he does not claim novelty for his view, I am not aware that it has ever been so well stated. External stimuli are supposed to act by altering this physiological state; that is, the organism is temporarily transformed into what, judged by its reactions, is practically a different creature.

This may be illustrated by the behaviour of Stentor, one of the fixed infusoria.[2] If a fine jet of water is directed against the disc of the creature, it contracts "like a flash" into its tube. In about half a minute it expands again and the cilia resume their activity. Now we cause the current to act again upon the disc. This time the Stentor does not contract, which proves that the animal has been in some way changed by the first stimulus. This is a simple example of "physiological state." When the Stentor was at rest, before it received the first current of water, it was in state 1, the stimulus changed state 1 into state 2, to which contraction is the reaction. When again stimulated it passed into state 3, which does not produce contraction.

We cannot prove that the contraction which occurred when the Stentor was first stimulated was due to a change of state. But it is a fair deduction from the result of the whole experiment, for after the original reaction the creature is undoubtedly in a changed state, since it no longer reacts in the same way to a repetition of the original stimulus.

Jennings points out that, as in the case of plants, spontaneous acts are brought about when the physiological state is changed by unknown causes, whereas in other cases we can point to an external agency by which the same result is effected.

*Morphological Changes.*

Let us pass on to the consideration of the permanent or morphological changes and the stimuli by which they are produced, a subject to which, in recent years, many workers have devoted themselves. I need only mention the names of Vöchting, Goebel, and Klebs among botanists, and those of Loeb, Herbst, and Driesch among zoologists, to remind you of the type of research to which I refer.

These morphological alterations produced by changes in environment have been brought under the rubric of reaction to stimulation, and must be considered as essentially similar to the class of temporary movements of which I have spoken.

The very first stage in development may be determined by a purely external stimulus. Thus the position of the first cell-wall in the developing spore of Equisetum is determined by the direction of incident light.[1] In the same way the direction of light settles the plane of symmetry of Marchantia as it develops from the gemma.[2] But the more interesting cases are those where the presence or absence of a stimulus makes an elaborate structural difference in the organism. Thus, as Stahl[3] has shown, beech leaves developed in the deep shade of the middle of the tree are so different in structure from leaves grown in full sunlight that they would unhesitatingly be described as belonging to different species. Another well-known case is the development of the scale-leaves on the rhizome of Circæa into the foliage leaves under the action of light.[4]

The power which the experimenter has over the lower plants is shown by Klebs, who kept *Saprolegnia mixta*, a fungus found on dead flies, in uninterrupted vegetative growth for six years; while by removing a fragment of the plant and cultivating it in other conditions the reproductive organs could at any time be made to appear.[5]

*Chlamydomonas media*, a unicellular green alga, when grown in a 0·4 per cent. nutrient solution continues to increase by simple division, but conjugating gametes are formed in a few days if the plant is placed in pure water and kept in bright light.[6] Numberless other cases could be given of the regulation of form in the lower organisms. Thus Sporodinia grown on peptone-gelatine produces sporangiferous hypha, but on sugar zygotes are formed. Again, *Protosiphon botryoides*, if grown on damp clay, can most readily be made to produce spores by transference to water either in light or in darkness. But for the same plant cultivated in Knop's solution the end can best be obtained by placing the culture in the dark.[7] Still these instances of the regulation of reproduction are not so interesting from our point of view as some of Klebs' later results.[8] Thus he has shown that the colour of the flower of *Campanula trachelium* can be changed from blue to white and back again to blue by varying the conditions under which the plant is cultivated. Again, with Sempervivum[9] he has been able to produce striking results—*e.g.*, the formation of apetalous flowers with one instead of two rows of stamens. Diminution in the number of stamens is a common occurrence in his experimental plants, and absolute loss of these organs also occurs. Many other abnormalities were induced, both in the stamens and in other parts of the flowers.

There is nothing new in the character of these facts;[10] what has been brought to light (principally by the work of Klebs) is the *degree* to which ontogeny is controllable. We are so much in the habit of thinking of the stable element in ontogeny that the work of Klebs strikes us with something of a shock. Most people would allow that change of form is ultimately referable to changed conditions, but many of us were not prepared to learn the great importance of external stimuli in ontogeny.

Klebs begins by assuming that every species has a definite *specific structure*, which he compares to chemical character. Just as a substance such as sulphur may assume different forms under different treatment, so he assumes that the specific structure of a plant has certain potentialities which may be brought to light by appropriate stimuli. He divides the agencies affecting the structure into external and internal conditions, the external being supposed to act by causing alterations in the internal conditions.

It will be seen that the scheme is broadly the same as that of Pfeffer for the case of the movement and other temporary reactions. The internal conditions of Klebs correspond also to the "physiological state" of Jennings.

From what has gone before, it will be seen that the

1 H. S. Jennings, "Contributions to the Study of the Behaviour of the Lower Organisms." Carnegie Institution, 1904, p. 111.

2 Jennings, "Behaviour of the Lower Organisms," 1906, p. 170.

1 Stahl, *Ber. d. Bot. Ges.*, 1885, p. 334.

2 Pfeffer, in Sachs' *Arbeiten*, i. p. 92.

3 *Jenaische Zeitschr.*, 1883, p. 162.

4 Goebel in *Bot. Zeitung*, 1880.

5 *Willkürliche Entwick.*, p. 27.

6 Klebs, *Bedingungen*, 1896, p. 430.

7 *Biol. Centralbl.*, 1904, pp. 451–3.

8 *Jahrb. f. wiss. Bot.*, xlii. 1906, p. 162.

9 *Abhandl. Naturforsch Ges. zu Halle*, xxv., 1906, pp. 31, 34, &c.

10 See the great collection of facts illustrating the "direct and definite action of the external conditions of life" in "Variation of Animals and Plants," ii. 271.

current conception of stimulus[1] is practically identical whether we look at the phenomena of movement or those of structure. If this is allowable—and the weight of evidence is strongly in its favour—a conclusion of some interest follows.

If we reconsider what I have called the indirectness of stimulation, we shall see that it has a wider bearing than is at first obvious. The "internal condition" or "physiological state" is a factor in the regulation of the organism's action, and it is a factor which owes its character to external agencies which may no longer exist.

The fact that stimuli are not momentary in effect but leave a trace of themselves on the organism is in fact the physical basis of the phenomena grouped under memory in its widest sense as indicating that action is regulated by past experience. Jennings[2] remarks: "In the higher animals, and especially in man, the essential features in behaviour depend very largely on the history of the individual; in other words, upon the present physiological condition of the individual, as determined by the stimuli it has received and the reactions it has performed. But in this respect the higher animals do not differ in principle, but only in degree, from the lower organisms. . . ." I venture to believe that this is true of plants as well as of animals, and that it is further broadly true not only of physiological behaviour, but of the changes that are classed as morphological.

Semon in his interesting book, "Die Mneme,"[3] has used the word *Engram* for the trace or record of a stimulus left on the organism. In this sense we may say that the internal conditions of Pfeffer, the physiological states of Jennings, and the internal conditions of Klebs are, broadly speaking, *Engrams*. The authors of these theories may perhaps object to this sweeping statement, but I venture to think it is broadly true.

The fact that in some cases we recognise the chemical or physical character of the internal conditions does not by any means prevent our ascribing a *mnemic* memory-like character to them, since they remain causal agencies built up by external conditions which have, or may have, ceased to exist. Memory will be none the less memory when we know something of the chemistry and physics of its neural concomitant.

*Habit illustrated by Movement.*

In order to make my meaning plain as to the existence of a *mnemic* factor in the life of plants, I shall for the moment leave the morphological side of life and give an instance of habitual movement.

Sleeping plants are those in which the leaves assume at night a position markedly different from that shown by day. Thus the leaflets of the scarlet-runner (Phaseolus) are more or less horizontal by day and sink down at night. This change of position is known to be produced by the alternation of day and night. But this statement by no means exhausts the interest of the phenomenon. A sensitive photographic plate behaves differently in light and darkness; and so does a radiometer, which spins by day and rests at night.

If a sleeping-plant is placed in a dark room after it has gone to sleep at night, it will be found next morning in the light-position, and will again assume the nocturnal position as evening comes on. We have, in fact, what seems to be a habit built by the alternation of day and night. The plant normally drops its leaves at the stimulus of darkness and raises them at the stimulus of light. But here we see the leaves rising and falling in the absence of the accustomed stimulation. Since this change of position is not due to external conditions it must be the result of the internal conditions which habitually accompany the movement. This is the characteristic *par excellence* of habit—namely, a capacity, acquired by repetition, of reacting to a fraction of the original environment. We may express it in simpler language. When a series of actions are compelled to follow each other by applying a series of stimuli they become organically tied together, or *associated*, and follow each other automatically, even when the whole series of stimuli are not acting. Thus in the formation of habit *post hoc* comes to be equivalent to *propter hoc*. Action B automatically follows action A, because it has repeatedly been compelled to follow it.

This may be compared with Herbert Spencer's[1] description of an imaginary case, that of a simple aquatic animal which contracts its tentacles on their being touched by a fish or a bit of seaweed washed against it. If such a creature is also sensitive to light the circumstances in which contraction takes place will be made up of two stimuli—those of light and of contact—following each other in rapid succession. And, according to the above statement of the essential character of associative habit, it will result that the light-stimulus alone may suffice, and the animal will contract without being touched.

Jennings[2] has shown that the basis of memory by association exists in so low an organism as the infusorian Stentor. When the animal is stimulated by a jet of water containing carmine in suspension, a physiological state A is produced, which, however, does not immediately lead to a visible reaction. As the carmine stimulus is continued or repeated, state B is produced, to which the Stentor reacts by bending to one side. After several repetitions of the stimulus, state C is produced, to which the animal responds by reversing its ciliary movement, and C finally passes into D, which results in the Stentor contracting into its tube. The important thing is that after many repetitions of the above treatment the organism "contracts at once as soon as the carmine comes in contact with it." In other words, states B and C are apparently omitted, and A passes directly into D, *i.e.*, into the state which gives contraction as a reaction. Thus we have in an infusorian a case of short-circuiting precisely like the case which has been quoted from Herbert Spencer as illustrating association. But Jennings' case has the advantage of being based on actual observation. He generalises the result as the "law of the resolution of physiological states" in the following words: "The resolution of one physiological state into another becomes easier and more rapid after it has taken place a number of times." He goes on to point out that the operation of this law is seen in the higher organisms, "in the phenomena which we commonly call memory, association, habit-formation, and learning."

In spite of this evidence of mnemic power in the simplest of organisms, objections will no doubt be made to the statement that association of engrams can occur in plants.

Pfeffer, whose authority none can question, accounts for the behaviour of sleeping plants principally on the more general ground that when any movement occurs in a plant there is a tendency for it to be followed by a reversal—a swing of the physiological pendulum in the other direction. Pfeffer[3] compares it to a released spring which makes several alternate movements before it settles down to equilibrium. But the fact that the return movements

[1] With regard to the terminology of stimulation, I believe that it would greatly simplify matters if our classification of causal conditions could be based on the relation of the nucleus to the rest of the cell. But our knowledge does not at present allow of more than a tentative statement of such a scheme. It is now widely believed that the nucleus is the bearer of the qualities transmitted from generation to generation, and the regulator of ontogeny. May we not therefore consider it probable that the nucleus plays in the cell the part of a central nervous system? In plants there is evidence that the ectoplasm is the sensitive region, and, in fact, plays the part of the cell's sense-organ. The change that occurs in the growth of a cell, as a response to stimulus, would on this scheme be a reflex action dependent for its character on the structure of the nucleus. The "indirectness" of stimulation would then depend on the reception by the nucleus of the excitation set up in the ectoplasm, and the secondary excitation reflected from the nucleus, leading to certain changes in the growth of the cell.

If the nucleus be the bearer of the past history of the individual, the scheme here sketched would accord with the adaptive character of normal reactions and would fall into line with what we know of the regulation of actions in the higher organisms. Pfeffer ("Physiology of Plants," Eng. trans., iii. 10) has briefly discussed the possibility of thus considering the nucleus as a reflex centre, and has pointed out difficulties in the way of accepting such a view as universally holding good. Delage ("L'Hérédité," 2nd edit., 1903, p. 88) gives a good summary of the evidence which induces him to deny the mastery of the cell by the nucleus. Driesch, however ("Analytische Theorie der organischen Entwicklung," 1894, p. 81), gives reasons for believing that the cytoplasm is the receptive region, while the nucleus is responsible for the reaction, and it is on this that he bases his earlier theory of ontogeny.

[2] P. 124 (1904).

[3] "Die Mneme, als erhaltendes Prinzip im Wechsel des organischen Geschehens," von Richard Semon, 1te Auflage, 1904, 2te Auflage, 1908. It is a pleasure to express my indebtedness to this work, as well as for the suggestions and criticisms which I owe to Prof. Semon personally.

[1] "Psychology," 2nd edit., 1870, vol. i. p. 435.

[2] "Behaviour of the Lower Organisms," 1906, p. 289.

[3] See Pfeffer, *Abhandl. K. Sächs. Ges.*, Bd. xxx. 1907. It is impossible to do justice to Pfeffer's point of view in the above brief statement.

occur at the same time-intervals as the stimuli is obviously the striking feature of the case. If the pendulum-like swing always tended to occur naturally in a twelve hours' rhythm it would be a different matter. But Pfeffer has shown that a rhythm of six hours can equally well be built up. And the experiments of Miss Pertz and myself[1] show that a half-hourly or quarter-hourly rhythm can be produced by alternate geotropic stimulation.

We are indebted to Keeble[2] for an interesting case of apparent habit among the lower animals. *Convoluta roscoffensis*, a minute worm-like creature found on the coast of Brittany, leads a life dependent on the ebb and flow of the sea. When the tide is out the Convoluta come to the surface, showing themselves in large green patches. As the rising tide begins to cover them they sink down into safer quarters. The remarkable fact is that when kept in an aquarium, and therefore removed from tidal action, they continue for a short time to perform rhythmic movements in time with the tide.

Let us take a human habit, for instance that of a man who goes a walk every day and turns back at a given mile-post. This becomes habitual, so that he reverses his walk automatically when the limit is reached. It is no explanation of the fact that the stimulus which makes him start from home includes his return—that he has a mental return-ticket. Such explanation does not account for the point at which he turns, which as a matter of fact is the result of association. In the same way a man who goes to sleep will ultimately wake; but the fact that he wakes at four in the morning depends on a habit built up by his being compelled to rise daily at that time. Even those who will deny that anything like association can occur in plants cannot deny that in the continuance of the nyctitropic rhythm in constant conditions we have, in plants, something which has general character of habit, *i.e.*, a rhythmic action depending on a rhythmic stimulus that has ceased to exist.

On the other hand, many will object that even the simplest form of association implies a nervous system. With regard to this objection it must be remembered that plants have two at least of the qualities characteristic of animals—namely, extreme sensitiveness to certain agencies and the power of transmitting stimuli from one part to another of the plant body. It is true that there is no central nervous system, nothing but a complex system of nuclei; but these have some of the qualities of nerve cells, while intercommunicating protoplasmic threads may play the part of nerves. Spencer[3] bases the power of association on the fact that every discharge conveyed by a nerve "leaves it in a state for conveying a subsequent like discharge with less resistance." Is it not possible that the same thing may be as true of plants as it apparently is ot infusoria? We have seen reasons to suppose that the "internal conditions" or "physiological states" in plants are of the nature of engrams, or residual effects of external stimuli, and such engrams may become associated in the same way.

There is likely to be another objection to my assumption that a simple form of associated action occurs in plants—namely, that association implies consciousness. It is impossible to know whether or not plants are conscious; but it is consistent with the doctrine of continuity that in all living things there is something psychic, and if we accept this point of view we must believe that in plants there exists a faint copy of what we know as consciousness in ourselves.[4]

I am told by psychologists that I must define my point of view. I am accused of occupying that unscientific position known as "sitting on the fence." It is said that, like other biologists, I try to pick out what suits my purpose from two opposite schools of thought—the psychological and the physiological.

What I claim is that, as regards reaction to environment, a plant and a man must be placed in the same great class, in spite of the obvious fact that as regards complexity of behaviour the difference between them is enormous. I am not a psychologist, and I am not bound to give an opinion as to how far the occurrence of definite actions in response to stimulus is a physiological and how far a psychological problem. I am told that I have no right to assume the neural series of changes to be the cause of the psychological series, though I am allowed to say that neural changes are the universal concomitants of psychological change. This seems to me, in my ignorance, an unsatisfactory position. I find myself obliged to believe that the mnemic quality in all living things (which is proved to exist by direct experiment) must depend on the physical changes in protoplasm, and that it is therefore permissible to use these changes as a notation in which the phenomena of habit may be expressed.

1 *Annals of Botany*, 1892 and 1903.
2 Gamble and Keeble, *Q. J. Mic. Science*, xlvii. p. 401.
3 "Psychology," 2nd edit., vol. i. p. 615.
4 See James Ward, "Naturalism and Agnosticism," vol. i., Lecture X.

*Habit illustrated by Morphology.*

We have hitherto been considering the mnemic quality of movements; but, as I have attempted to show, morphological changes are reactions to stimulation of the same kind as these temporary changes. It is indeed from the morphological reactions of living things that the most striking cases of habit are, in my opinion, to be found.

The development of the individual from the germ-cell takes place by a series of stages of cell-division and growth, each stage apparently serving as a stimulus to the next, each unit following its predecessor like the movements linked together in an habitual action performed by an animal.

My view is that the rhythm of ontogeny is actually and literally a habit. It undoubtedly has the feature which I have described as preeminently characteristic of habit, viz., an automatic quality which is seen in the performance of a series of actions in the absence of the complete series of stimuli to which they (the stages of ontogeny) were originally due. This is the chief point on which I wish to insist—I mean that the resemblance between ontogeny and habit is not merely superficial, but deeply seated. It was with this conclusion in view that I dwelt, at the risk of being tedious, on the fact that memory has its place in the morphological as well as in the temporary reactions of living things. It cannot be denied that the ontogenetic rhythm has the two qualities observable in habit—namely, a certain degree of fixity or automaticity, and also a certain variability. A habit is not irrevocably fixed, but may be altered in various ways. Parts of it may be forgotten or new links may be added to it. In ontogeny the fixity is especially observable in the earlier, the variability in the later, stages. Mr. Darwin has pointed out that "on the view that species are only strongly marked and fixed varieties, we might expect often to find them still continuing to vary in those parts of their structure which have varied within a moderately recent period." These remarks are in explanation of the "notorious" fact that specific are more variable than generic character—a fact for which it is "almost superfluous to adduce evidence."[1] This, again, is what we find in habit: take the case of a man who, from his youth up, has daily repeated a certain form of words. If in middle life an addition is made to the formula, he will find the recently acquired part more liable to vary than the rest.

Again, there is the wonderful fact that, as the ovum develops into the perfect organism, it passes through a series of changes which are believed to represent the successive forms through which its ancestors passed in the process of evolution. This is precisely paralleled by our own experience of memory, for it often happens that we cannot reproduce the last learned verse of a poem without repeating the earlier part; each verse is suggested by the previous one and acts as a stimulus for the next. The blurred and imperfect character of the ontogenetic version of the phylogenetic series may at least remind us of the tendency to abbreviate by omission what we have learned by heart.

In all bi-sexual organisms the ontogenetic rhythm of the offspring is a combination of the rhythms of its parents. This may or may not be visible in the offspring; thus in the crossing of two varieties the mongrel assumes the character of the prepotent parent. Or the offspring

1 "Origin of Species, 6th edit., p. 22.

may show a blend of both parental characters. Semon[1] uses as a model the two versions of Goethe's poem—

"Ueber allen Gipfeln, ist Ruh, in allen { Wäldern, horest du, keinen Hauch." / Wipfeln, spürest du, kaum einen Hauch."

One of these terminations will generally be prepotent, probably the one that was heard first or heard most often. But the cause of such prepotency may be as obscure as the corresponding occurrence in the formation of mongrels. We can only say that in some persons the word "allen" releases the word "Wäldern," while in others it leads up to "Wipfeln." Again, a mixture of the terminations may occur leading to such a mongrel form as: "in allen Wäldern hörest du kaum einen Hauch." The same thing is true of music; a man with an imperfect memory easily interpolates in a melody a bar that belongs elsewhere. In the case of memory the introduction of a link from one mental rhythm into another can only occur when the two series are closely similar, and this may remind us of the difficulty of making a cross between distantly related forms.

Enough has been said to show that there is a resemblance between the two rhythms of development and of memory; and that there is at least a *prima facie* case for believing them to be essentially similar. It will be seen that my view is the same as that of Hering, which is generally described as the identification of memory and inheritance.[2] Hering says that "between the *me* of to-day and the *me* of yesterday lie night and sleep, abysses of unconsciousness; nor is there any bridge but memory with which to span them." And in the same way he claims that the abyss between two generations is bridged by the unconscious memory that resides in the germ-cells. It is also the same as that of Semon and to a great extent as that of Rignano.[3] I, however, prefer at the moment to limit myself to asserting the identity of ontogeny and habit, or, more generally, to the assertion in Semon's phraseology, that ontogeny is a mnemic phenomenon.

Evolution, in its modern sense, depends on a change in the ontogenetic rhythm. This is obvious, since if this rhythm is absolutely fixed, a species can never give rise to varieties. This being so, we have to ask *in what ways* the ontogenetic rhythm can be altered. An habitual action, for instance, a trick learned by a dog, may be altered by adding new accomplishments; at first the animal will persist in finishing his performance at the old place, but at last the extended trick will be bonded into a rhythm of actions as fixed as was the original simpler performance. May we not believe that this is what has occurred in evolution?

We know from experiment that a plant may be altered in form by causes acting on it during the progress of development. Thus a beech tree may be made to develop different forms of leaves by exposing it to sunshine or to shade. The ontogeny is different in the two cases, and what is of special interest is, that there exist shade-loving plants in which a structure similar to that of the shaded beech-leaf is apparently typical of the species, but on this point it is necessary to speak with caution. In the same way Goebel points out that in some orchids the assimilating roots take on a flattened form when exposed to sunlight, but in others this morphological change has become automatic, and occurs even in darkness.[4]

Such cases suggest at least the possibility of varieties arising as changes in or additions to the later stages of ontogeny. This is, briefly given, the epigenetic point of view.

But there is another way of looking at the matter—namely, that upheld by Galton and Weismann. According to this view ontogeny can only be changed by a fundamental upset of the whole system—namely, by an alteration occurring in its first stage, the germ-cell, and this view is now very generally accepted.

The same type of change may conceivably occur in memory or habit, that is, the rhythm as a whole may be altered by some cause acting on the nerve-centres connected with the earlier links of the series. The analogy is not exact, but such an imaginary case is at least of a different type from a change in habit consisting in the addition of a new link or the alteration of one of the latest formed links. If we were as ignorant of the growth of human actions as we are of variation, we might have a school of naturalists asserting that all changes in habit originate in the earliest link of the series. But we know that this is not the case. On the other hand, I fully admit that the structure of an ovum may in this way be altered, and give rise to a variation which may be the starting-point of a new species.

But how can a new species originate according to an epigenetic theory? How can a change in the latter stages of ontogeny produce a permanent alteration in the germ-cells? Our answer to this question will depend on our views of the structure of the germ-cells. According to the mnemic theory they have the quality which is found in the highest perfection in nerve-cells, but is at the same time a character of all living matter—namely, the power of retaining the residual effects of former stimuli and of giving forth or reproducing under certain conditions an echo of the original stimulus. In Semon's phraseology germ-cells must, like nerve-cells, contain engrams, and these engrams must be (like nerve-engrams) bonded together by association, so that they come into action one after another in a certain order automatically, *i.e.*, in the absence of the original stimuli.

This seems to me the strength of the mnemic theory—namely, that it accounts for the preformed character of germ-cells by the building up in them of an organised series of engrams. But if this view has its strength, it has also its weakness. Routine can only be built up by repetition, but each stage in ontogeny occurs only once in a lifetime. Therefore if ontogeny is a routine each generation must be mnemically connected with the next. This can only be possible if the germ-cells are, as it were, in telegraphic communication with the whole body of the organism; so that as ontogeny is changed by the addition of new characters, new engrams are added to the germ-cell.

Thus in fact the mnemic theory of development depends on the possibility of what is known as somatic inheritance or the inheritance of acquired characters. This is obvious to all those familiar with the subject, but to others it may not be so clear. Somatic inheritance is popularly interesting in relation to the possible inherited effects of education, or of mutilations, or of the effects of use and disuse. It is forgotten that it may be, as I have tried to show, an integral part of all evolutionary development.

### *Weismann's Theory.*

Everyone must allow that if Weismann's theory of inheritance is accepted we cannot admit the possibility of somatic inheritance. This may be made clear to those unfamiliar with the subject by an illustration taken from the economy of an ant's nest or beehive. The queen[1] on whom depends the future of the race is cut off from all active experience of life: she is a mere reproducing machine, housed, fed, and protected by the workers. But these, on whom falls the burden of the struggle for life and the experience of the world generally, are sterile, and take no direct share in the reproduction of the species. The queen represents Weismann's germ-plasm, the workers are the body or soma. Now imagine the colony exposed to some injurious change in environment; the salvation of the species will depend on whether or no an improved pattern of worker can be produced. This depends on the occurrence of appropriate variations, so that the queen bee and the drones, on whom this depends, are of central importance. On the other hand any change occurring in the workers, for instance, increased skill due to practice in doing their work or changes in their structure due to external conditions, cannot possibly be inherited, since

1 "Die Mneme." 2nd edit., pp. 147, 221, 303, 345.

2 Everyone who deals with this subject must take his stand on the foundation laid by Hering in his celebrated address given at Vienna in 1870 and reprinted in No. 148 of Ostwald's *Exakt Klassiker* The passage quoted (p. 14) is from Samuel Butler's translation of Hering in "Unconscious Memory," 1880, p. 110. Butler had previously elaborated the view that "we are one person with our ancestors" in his entertaining book "Life and Habit," 1878, and this was written in ignorance of Hering's views.

3 "Sur la Transmissibilité des Caractères acquis." Paris, 1906.

4 Goebel's "Organography of Plants," part ii., p. 285.

1 Nor do the drones share the activity of the workers.

workers are absolutely cut off from the reproduction of the race. According to Weismann, there is precisely the same bar to the inheritance of somatic change.

The racial or phyletic life of all organisms is conceived by him as a series of germ-cells the activity of which is limited to varying, and the survival of which in any generation depends on the production of a successful soma or body capable of housing, protecting, and feeding the germ-cell. Most people would *a priori* declare that a community where experience and action are separated must fail. But the bee's nest, which must be allowed to be something more than an illustration of Weismann's theory, proves the contrary.

It is clear that there must be war to the knife between the theory of Weismann and that of the somatists—to coin a name for those who believe in the inheritance of acquired characters. A few illustrations may be given of the strength of Weismann's position. Some trick or trivial habit appears in two successive generations, and the son is said to inherit it from his father. But this is not necessarily a case of somatic inheritance, since according to Weismann the germ-plasm of both father and son contained the potentiality of the habit in question. If we keep constantly in view Weismann's theory of continuity, the facts which are supposed to prove somatic inheritance cease to be decisive.

Weismann has also shown by means of his hypothesis of "simultaneous stimulation"[1] the unconvincingness of a certain type of experiment. Thus Fischer showed that when chrysalids of *Arctia caja* are subjected to low temperature a certain number of them produce dark-coloured insects; and further that these moths mated together yield dark-coloured offspring. This has been held to prove somatic inheritance, but Weismann points out that it is explicable by the low temperature having an identical effect on the colour-determinants existing in the wing-rudiments of the pupa, and on the same determinants occurring in the germ-cells.

It does not seem to me worth while to go in detail into the evidence by which somatists strive to prove their point, because I do not know of any facts which are really decisive. That is to say, that though they are explicable as due to somatic inheritance, they never seem to me absolutely inexplicable on Weismann's hypothesis. But, as already pointed out, it is not necessary to look for special facts and experiments, since if the mnemic theory of ontogeny is accepted the development of every organism in the world depends on somatic inheritance.

I fully acknowledge the strength of Weismann's position; I acknowledge also most fully that it requires a stronger man than myself to meet that trained and well-tried fighter. Nevertheless, I shall venture on a few remarks. It must be remembered that, as Romanes[2] pointed out, Weismann has greatly strengthened his theory of heredity by giving up the absolute stability and perpetual continuity of germ-plasm. Germ-plasm is no longer that mysterious entity, immortal and self-contained, which used to suggest a physical soul. It is no longer the aristocrat it was when its only activity was dependent on its protozoan ancestors, when it reigned absolutely aloof from its contemporary subjects. The germ-plasm theory of to-day is liberalised, though it is not so democratic as its brother sovereign Pangenesis, who reigns, or used to reign, by an elaborate system of proportional representation. But in spite of the skill and energy devoted to its improvement by its distinguished author, Weismannism fails, in my opinion, to be a satisfactory theory of evolution.

All such theories must account for two things which are parts of a single process but may logically be considered separately: (i) The fact of ontogeny, namely, that the ovum has the capacity of developing into a certain more or less predetermined form; (ii) The fact of heredity—the circumstance that this form is approximately the same as that of the parent.

The doctrine of pangenesis accounts for heredity, since the germ-cells are imagined as made up of gemmules representing all parts of the adult; but it does not account for ontogeny, because there seems to me no sufficient reason why the gemmules should become active in a predetermined order unless, indeed, we allow that they do so by habit, and then the doctrine of pangenesis becomes a variant of the mnemic theory.

[1] I borrow this convenient expression from Plate's excellent book, "Ueber die Bedeutung des Darwin'schen Selectionsprincips," 1903, p. 81.

[2] "An Examination of Weismann," 1893, pp. 169, 170.

The strength of Weismann's theory lies in its explanation of heredity. According to the doctrine of continuity, a fragment of the germ-plasm is, as it were, put on one side and saved up to make the germ-cell of the new generation, so that the germ-cells of two successive generations are made of the same material. This again depends on Weismann's belief that when the ovum divides, the two daughter cells are not identical; that in fact the fundamental difference between soma and germ-cells begins at this point. But this is precisely where many naturalists whose observations are worthy of all respect differ from him. Weismann's theory is therefore threatened at the very foundation.

Even if we allow Weismann's method of providing for the identity between the germ-cell of two successive generations, there remains, as above indicated, a greater problem—namely, that of ontogeny. We no longer look at the potentiality of a germ-cell as Caliban looked on Setebos, as something essentially incomprehensible ruling the future in an unknown way—"just choosing so." If the modern germ-cell is to have a poetic analogue it must be compared to a Pandora's box of architectonic sprites which are let loose in definite order, each serving as a master builder for a prescribed stage of ontogeny. Weismann's view of the mechanism by which his determinants—the architectonic sprites—come into action in due order is, I assume, satisfactory to many, but I confess that I find it difficult to grasp. The orderly distribution of determinants depends primarily on their arrangement in the ids, where they are held together by "vital affinities." They are guided to the cells on which they are to act by differential divisions, in each of which the determinants are sorted into two unequal lots. They then become active, *i.e.*, break up into biophores, partly under the influence of liberating stimuli and partly by an automatic process. Finally the biophores communicate a "definite vital force" to the appropriate cells.[1] This *may* be a description of what happens; but inasmuch as it fails to connect the process of ontogeny with physiological processes of which we have definite knowledge, it does not to me seem a convincing explanation.

For myself I can only say that I am not satisfied with Weismann's theory of heredity or of ontogeny. As regards the first, I incline to deny the distinction between germ and soma, to insist on the plain facts that the soma is continuous with the germ-cell, and that the somatic cells may have the same reproductive qualities as the germ-cells (as is proved by the facts of regeneration); that, in fact, the germ-cell is merely a specialised somatic cell and has the essential qualities of the soma. With regard to ontogeny, I have already pointed out that Weismann does not seem to explain its automatic character.

### *The Mnemic Theory.*

If the mnemic theory is compared with Weismann's views it is clear that it is strong precisely where these are weakest—namely, in giving a coherent theory of the rhythm of development. It also bears comparison with all theories in which the conception of determinants occurs. Why should we make elaborate theories of hypothetical determinants to account for the potentialities lying hidden in the germ-cell, and neglect the only determinants of the existence of which we have positive knowledge (though we do not know their precise nature)? We know positively that by making a dog sit up and then giving him a biscuit we build up something in his brain in consequence of which a biscuit becomes the stimulus to the act of sitting. The mnemic theory assumes that the determinants of morphological change are of the same type as the structural alteration wrought in the dog's brain.

The mnemic theory—at any rate that form of it held by Semon and by myself—agrees with the current view, viz., that the nucleus is the centre of development, or, in Semon's phraseology, that the nucleus contains the

[1] "The Evolution Theory," Eng. trans., i. 373 *et seq.*

engrams in which lies the secret of the ontogenetic rhythm. But the mode of action of the mnemic nucleus is completely different from that of Weismann. He assumes that the nucleus is disintegrated in the course of development by the dropping from it of the determinants which regulate the manner of growth of successive groups of cells. But if the potentiality of the germ nucleus depends on the presence of engrams, if, in fact, its function is comparable to that of a nerve-centre, its capacity is not diminished by action; it does not cast out engrams from its substance as Weismann's nucleus is assumed to drop armies of determinants. The engrams are but cut deeper into the records, and more closely bonded one with the next. The nucleus, considered as a machine, does not lose its component parts in the course of use. We shall see later on that the nuclei of the whole body may, on the mnemic theory, be believed to become alike. The fact that the mnemic theory allows the nucleus to retain its repeating or reproductive or mnemic quality supplies the element of continuity. The germ-cell divides and its daughter cells form the tissues of the embryo, and in this process the original nucleus has given rise to a group of nuclei; these, however, have not lost their engrams, but retain the potentiality of the parent nucleus. We need not therefore postulate the special form of continuity which is characteristic of Weismann's theory.

We may say, therefore, that the mnemic hypothesis harmonises with the facts of heredity and ontogeny. But the real difficulties remain to be considered, and these, I confess, are of a terrifying magnitude.

The first difficulty is the question how the changes arising in the soma are, so to speak, telegraphed to the germ-cells. Hering allows that such communication must at first seem highly mysterious.[1] He then proceeds to show how by the essential unity and yet extreme ramification of the nervous system "all parts of the body are so connected that what happens in one echoes through the rest, so that from the disturbance occurring in any part some notification, faint though it may be, is conveyed to the most distant parts of the body."

A similar explanation is given by Nägeli. He supposes that adaptive, in contradistinction to organic, characters are produced by external causes; and since these characters are hereditary there must be communication between the seat of adaptation and the germ-cells. This telegraphic effect is supposed to be effected by the network of idioplasm which traverses the body, in the case of plants by the intercellular protoplasmic threads.

Semon faces the difficulty boldly. When a new character appears in the body of an organism, in response to changing environment, Semon assumes that a new engram is added to the nuclei in the part affected; and that, further, the disturbance tends to spread to all the nuclei of the body (including those of the germ-cells), and to produce in them the same change. In plants the flow must be conceived as travelling by intercellular plasmic threads, but in animals primarily by nerve-trunks. Thus the reproductive elements must be considered as having in some degree the character of nerve-cells. So that, for instance, if we are to believe that an individual habit may be inherited and appear as an instinct, the repetition of the habit will not merely mean changes in the central nervous system, but also corresponding changes in the germ-cells. These will be, according to Semon, excessively faint in comparison to the nerve-engrams, and can only be made efficient by prolonged action. Semon lays great stress on the slowness of the process of building up efficient engrams in the germ-cells.

Weismann[2] speaks of the impossibility of germinal engrams being formed in this way. He objects that nerve-currents can only differ from each other in intensity, and therefore there can be no communication of potentialities to the germ-cell. He holds it to be impossible that somatic changes should be telegraphed to the germ-cell and be reproduced ontogenetically—a process which he compares to a telegram despatched in German and arriving in Chinese. According to Semon,[1] what radiates from the point of stimulation in the soma is the primary excitation set up in the somatic cells; if this is so, the radiating influence will produce the same effect on all the nuclei of the organism. My own point of view is the following. In a plant (as already pointed out) the ectoplasm may be compared to the sense-organ of the cell, and the primary excitation of the cell will be a change in the ectoplasm; but since cells are connected by ectoplasmic threads the primary excitation will spread and produce in other cells a faint copy of the engram impressed on the somatic cells originally stimulated. But in all these assumptions we are met by the question to which Weismann has directed attention—namely, whether nervous impulses can differ from one another in *quality*?[2] The general opinion of physiologists is undoubtedly to the opposite effect—namely, that all nervous impulses are identical in quality. But there are notable exceptions, for instance, Hering,[3] who strongly supports what may be called the qualitative theory. I am not competent to form an opinion on the subject, but I confess to being impressed by Hering's argument that the nerve-cell and nerve-fibre, as parts of one individual (the neuron), must have a common irritability. On the other hand there is striking evidence, in Langley's[4] experiments on the cross-grafting of efferent nerves, that here at least nerve impulses are interchangeable and therefore identical in quality. The state of knowledge as regards afferent nerves is, however, more favourable to my point of view. For the difficulties that meet the physiologist—especially as regards the nerves of smell and hearing—are so great that it has been found simpler to assume differences in impulse-quality, rather than attempt an explanation of the facts on the other hypothesis.[5]

On the whole it may be said that, although the trend of physiological opinion is against the general existence of qualitative differences in nerve-impulses, yet the question cannot be said to be settled either one way or the other.

Another obvious difficulty is to imagine how within a single cell the engrams or potentialities of a number of actions can be locked up. We can only answer that the nucleus is admittedly very complex in structure. It may be added (but this not an answer) that in this respect it claims no more than its neighbours; it need not be more complex than Weismann's germ-plasm. One conceivable simplification seems to be in the direction of the pangenes of De Vries. He imagines that these heritage-units are relatively small in number, and that they produce complex results by combination, not by each being responsible for a minute fraction of the total result.[6] They may be compared to the letters of the alphabet which by combination make an infinity of words.[7] Nägeli[8] held a similar view. "To understand heredity," he wrote, "we do not need a special independent symbol for every difference conditioned by space, time, or quality, but a substance which can represent every possible combination of differences by the fitting together of a limited number of elements, and which can be transformed by permutations into other combinations." He applied (*loc. cit.*, p. 59) the idea of a combination of symbols to the telegraphic quality of his idioplasm. He suggests that as the nerves convey the most varied perceptions of external objects to the central nervous system, and there create a coherent picture, so it is not impossible that the idioplasm may convey a combination of its local alterations to other parts of the organism.

Another theory of simplified telegraphy between soma and germ-cell is given by Rignano.[9] I regret that the

[1] E. Hering in Ostwald's *Klassiker der exakten Wissenschaften*, No. 148, p. 14; see also S. Butler's translation in "Unconscious Memory," p. 119.

[2] Weismann, "The Evolution Theory," 1904, vol. ii. p. 63; also his "Richard Semon's 'Mneme' und die Vererbung erworbener Eigenschaften," in the *Archiv für Rassen- und Gesellschafts-Biologie*, 1906. Semon has replied in the same journal for 1907.

[1] Semon, "Mneme," ed. i. p. 142, does not, however, consider it proved that the nucleus is necessarily the smallest element in which the whole inheritance resides. He refers especially to the regeneration of sections of Stentor which contain mere fragments of the nucleus.

[2] I use this word in the ordinary sense without reference to what is known as *modality*.

[3] "Zur Theorie der Nerventhätigkeit," Akademische Vortrag, 1898 (Veit, Leipzig).

[4] Proc. R. Soc., 1904, p. 99. *Journal of Physiology*, xxiii. p. 240, and xxxi. p. 365.

[5] See Nagel, "Handbuch der Physiologie des Menschen," iii. (1905), pp. 1–15.

[6] De Vries, "Intracellular Pangenesis," p. 7.

[7] I take this comparison from Lotsy's account of De Vries's theory. Lotsy, "Vorlesungen über Deszendenztheorien," 1906, i. p. 98.

[8] Nägeli's "Abstammungslehre," 1884. p. 73.

[9] For what is here given I am partly indebted to Signor Rignano's letters.

space at my command does not permit me to give a full account of his interesting speculation on somatic inheritance. It resembles the theories of Hering, Butler, and Semon in postulating a quality of living things, which is the basis both of memory and inheritance. But it differs from them in seeking for a physical explanation or model of what is common to the two. He compares the nucleus to an electric accumulator which in its discharge gives out the same sort of energy that it has received. How far this is an allowable parallel I am not prepared to say, and in what follows I have given Rignano's results in biological terms. What interests me is the conclusion that the impulse conveyed to the nucleus of the germ-cell is, as far as results are concerned, the external stimulus. Thus, if a somatic cell (A) is induced by an external stimulus (S) acting on the nucleus to assume a new manner of development, a disturbance spreads through the organism, so that finally the nuclei of the germ-cells are altered in a similar manner. When the cellular descendants of the germ-cells reach the same stage of ontogeny as that in which the original stimulation occurred, a stimulus comes into action equivalent to S as regards the results it is capable of producing. So that the change originally wrought in cell A by the actual stimulus S is now reproduced by what may be called an inherited stimulus. But when A was originally affected other cells, B, C, D, may have reacted to S by various forms of growth. And therefore when during the development of the altered germ-cell something equivalent to S comes into play, there will be induced, not merely the original change in the development of A, but also the changes which were originally induced in the growth of B, C, D. Thus, according to Rignano, the germ-nucleus releases a number of developmental processes, each of which would, according to Weismann, require a separate determinant.

If the view here given is accepted, we must take a new view of Weismann's cases of *simultaneous stimulation, i.e.*, cases like Fischer's experiments on *Arctia caja*, which he does not allow to be somatic inheritance. If we are right in saying that, the original excitation of the soma is transferred to the germ-cell, and it does not matter whether the stimulus is transferred by "telegraphy," or whether a given cause, *e.g.*, a low temperature, acts simultaneously on soma and germ-cell. In both cases we have a given alteration produced in the nuclei of the soma and the germ-cell. Nägeli used the word *telegraphy* to mean a dynamic form of transference, but he did not exclude the possibility of the same effect being produced by the movement of chemical substances, and went so far as to suggest that the sieve tubes might convey such stimuli in plants. In any case this point of view [1] deserves careful consideration.

Still another code of communication seems to me to be at least conceivable. One of the most obvious characteristics of animal life is the guidance of the organism by certain groups of stimuli, producing either a movement of seeking (positive reaction [2]) or one of avoidance (negative reaction). Taking the latter as being the simplest, we find that in the lowest as in the highest organisms a given reaction follows each one of a number of diverse conditions which have nothing in common save that they are broadly harmful in character. We withdraw our hands from a heated body, a prick, a corrosive substance, or an electric shock. The interesting point is that it is left to the organism to discover by the method of trial and error the best means of dealing with a sub-injurious stimulus. May we not therefore say that the existence of pleasure and pain simplifies inheritance? It certainly renders unnecessary a great deal of detailed inheritance. The innumerable appropriate movements performed by animals are broadly the same as those of their parents, but they are not necessarily inherited in every detail; they are rather the unavoidable outcome of hereditary but unspecialised sensitiveness. It is as though heredity were arranged on a code-system instead of by separate signals for every movement of the organism.

It may be said that in individual life the penalty of failure is pain, but that the penalty for failure in ontogenetic morphology is death. But it is only because pain is the shadow cast by Death as he approaches that it is of value to the organism. Death would be still the penalty of creatures that had not acquired this sensitiveness to the edge of danger. Is it not possible that the sensitiveness to external agencies by which structural ontogeny is undoubtedly guided may have a similar quality, and that morphological variations may also be reactions to the edge of danger. But this is a point of view I cannot now enter upon.

It may be objected that the inheritance of anything so complex as an instinct is difficult to conceive on the mnemic theory. Yet it is impossible to avoid suspecting that at least some instincts originate in individual acquirements, since they are continuous with habits gained in the lifetime of the organism. Thus the tendency to peck at any small object is undoubtedly inherited; the power of distinguishing suitable from unsuitable objects is gained by experience. It may be said that the engrams concerned in the pecking instinct cannot conceivably be transferred from the central nervous system to the nucleus of the germ-cells. To this I might answer that this is not more inconceivable than Weismann's assumption that the germ-cell chances to be so altered that the young chicken pecks instinctively. Let us consider another case of what appears to be an hereditary movement. Take, for instance, the case of a young dog, who in fighting bites his own lips. The pain thus produced will induce him to tuck up his lips out of harm's way. This protective movement will become firmly associated with, not only the act of fighting, but with the remembrance of it, and will show itself in the familiar snarl of the angry dog. This movement is now, I presume, hereditary in dogs, and is so strongly inherited by ourselves (from simian ancestors) that a lifting of the corner of the upper lip is a recognised signal of adverse feeling. Is it really conceivable that the original snarl is due to that unspecialised stimulus we call pain, whereas the inherited snarl is due to fortuitous upsets of the determinants in the germ-cell?

I am well aware that many other objections may be advanced against the views I advocate. To take a single instance, there are many cases where we should expect somatic inheritance, but where we look in vain for it. This difficulty, and others equally important, must for the present be passed over. Nor shall I say anything more as to the possible means of communication between the soma and the germ-cells. To me it seems conceivable that some such telegraphy is possible. But I shall hardly wonder if a majority of my hearers decide that the available evidence in its favour is both weak and fantastic. Nor can I wonder that, apart from the problem of mechanism, the existence of somatic inheritance is denied for want of evidence. But I must once more insist that, according to the mnemic hypothesis, somatic inheritance lies at the root of all evolution. Life is a gigantic experiment which the opposing schools interpret in opposite ways. I hope that in this dispute both sides will seek out and welcome decisive results. My own conviction in favour of somatic inheritance rests primarily on the automatic element in ontogeny. It seems to me certain that in development we have an actual instance of habit. If this is so, somatic inheritance must be a *vera causa*. Nor does it seem impossible that memory should rule the plasmic link which connects successive generations—the true miracle of the camel passing through the eye of a needle—since, as I have tried to show, the reactions of living things to their surroundings exhibit in the plainest way the universal presence of a mnemic factor.

We may fix our eyes on phylogeny and regard the living world as a great chain of forms, each of which has learned something of which its predecessors were ignorant; or we may attend rather to ontogeny, where the lessons learned become in part automatic. But we must remember that the distinction between phylogeny and ontogeny is an artificial one, and that routine and acquisition are blended in life.[1]

[1] See Semon, *Archiv f. Rassen- und Gesellschafts-Biologie*, 1907, p. 39.
[2] See Jennings, "Behaviour of the Lower Organisms."

[1] This subject is dealt with in a very interesting manner in Prof. James Ward's forthcoming lectures on the "Realm of Ends." Also in his article on "Mechanism and Morals" in the *Hibbert Journal*, October, 1905 p. 92; and in his article on "Psychology" in the "Encyclopædia Britannica," 1886, vol. xx. p. 44.

The great engine of natural selection is taunted nowadays, as it was fifty years ago, with being merely a negative power. I venture to think that the mnemic hypothesis of evolution makes the positive value of natural selection more obvious. If evolution is a process of drilling organisms into habits, the elimination of those that cannot learn is an integral part of the process, and is no less real because it is carried out by a self-acting system. It is surely a positive gain to the harmony of the universe that the discordant strings should break. But natural selection does more than this; and just as a trainer insists on his performing dogs accommodating themselves to conditions of increasing complexity, so does natural selection pass on its pupils from one set of conditions to other and more elaborate tests, insisting that they shall endlessly repeat what they have learned and forcing them to learn something new. Natural selection attains in a blind, mechanical way the ends gained by a human breeder; and by an extension of the same metaphor it may be said to have the power of a trainer—of an automatic master with endless patience and all time at his disposal.

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## SECTION A.

### MATHEMATICS AND PHYSICS.

Opening Address by W. N. Shaw, Sc.D., LL.D., F.R.S., President of the Section.

It is with much misgiving that I endeavour to discharge the traditional duty of the President of a Section of the British Association. So many other duties seem to find a natural resting-place with anyone who has to reckon at the same time with the immediate requirements of the public, the claims of scientific opinion, and the interests of posterity, that, unless you are content with such contribution towards the advancement of the sciences of mathematics and physics as my daily experience enables me to offer you, I shall find the task impossible.

With a leaning towards periodicity perhaps slightly unorthodox I have looked back to see what they were doing in Section A fifty years ago. Richard Owen was President of the Association, William Whewell was President of Section A for the fifth time.

At the meeting of 1858 they must have spent some time over nineteen very substantial reports on researches in science, which included a large section of Mallett's facts and theory of earthquake phenomena, magnetic surveys of Great Britain and of Ireland, and, oddly enough, an account of the self-recording anemometer by Beckley; perhaps a longer time was required for fifty-seven Papers contributed to the Section, but very little was spent over the Presidential Address, for it only occupies two pages of print. My inclination towards periodicities and another consideration lead me to regard the precedent as a good one. That other consideration is that Section A has always more subjects for discussion than it can properly dispose of; and, in this case, discipline, like charity, might begin at home.

Since the Section met last year it has lost its most illustrious member and its most faithful friend. Lord Kelvin made his first contribution to Section A at Cambridge in 1845, on the elementary laws of statical electricity; he was President of the Section in 1852 at Belfast for the first of five times. I have looked to see what suggestion I could derive from his first essay in that capacity. I can find no reference to any Address in the published volume. I wish I had the courage to follow that great example.

Lord Kelvin's association with Section A was so constant and so intimate that it requires more than a passing word of reference. There is probably no student of Mathematics or Physics grown into a position of responsibility in this country but keeps among his treasured reminiscences some words of inspiration and of encouragement from Kelvin, spoken in the surroundings which we are once more met to inaugurate. I refer to those unrecorded acts of kindness and help because they were really a striking characteristic of Section A. Their value for the amenity as well as for the advancement of science it would be difficult to overestimate. I could not, even if time permitted, hope to set before you an adequate appreciation of Kelvin's contributions to Science as illustrated by his communications to this Section, and in this place it is not necessary. But I cannot pass over that feature of his character without notice.

Closely following on the loss of Kelvin came the death of Sir Richard Strachey, a personal loss to which it is difficult to give expression. I am not aware that he had much to do with Section A. I wish, indeed, that the Section had seen its way to bring him more closely into touch with its proceedings. He was President of Section E in 1875, and, by appointment of the Royal Society, he was for twenty-two years Chairman of the Meteorological Council. I had the good fortune to be very closely associated with him during the last ten years of his life, and to realise the ideas which lay behind his official actions and to appreciate the reality of his services to science in the past and for the future.

These losses unfortunately do not stand alone. Only last year Sir John Eliot received the congratulations of all his fellow-workers upon the publication of his Climatological Atlas of India as representing the most conspicuous achievement of orderly, deliberate, purposeful compilation of meteorological facts for a special area that has yet been seen. He was full of projects for a handbook to accompany the atlas, and of ideas for the prosecution of meteorological research over wide areas by collecting information from all the world and enlisting the active cooperation of the constituent parts of the British Empire in using those observations for the advancement of science and the benefit of mankind. He died quite suddenly on March 18, not young as years go, but quite youthful in the deliberate purpose of manifold scientific activities and in his irrepressible faith in the future of the science which he has adorned.

The Section will, I hope, forgive me if I put before them some considerations which the careers of these three men suggest. Kelvin, a mathematician, a natural philosopher, a University Professor, some part of whose scientific work is known to each one of us. He was possessed with the notion that Mathematics and Natural Philosophy are applicable in every part of the work of daily life, and made good the contention by presenting to the world, besides innumerable theoretical papers, instruments of all degrees of complexity, from the harmonic analyser to an improved water-tap. It was he who transfigured and transformed the mariner's compass and the lead-line into instruments which have been of the greatest practical service. It was he who, when experimental science was merely a collection of facts or generalisations, conceived the idea of transfiguring every branch of it by the application of the principles of natural philosophy, as Newton had transfigured astronomy. The ambition of Thomson and Tait's "Natural Philosophy," of which only the first volume reached the stage of publication, is a fair index of Kelvin's genius.

Strachey, on the other hand, by profession a military engineer, a great administrator, head of the Public Works Department in India, deeply versed in finance and in all the other constituent parts of administration, by his own natural instinct demanded the assistance of science for every branch of administration. In promoting the development of botany, of meteorology, of geodesy, and of mathematics, he was not administering the patronage of a Macænas, but claiming the practical service of science in forestry, in agriculture, in famine relief, in public works, and in finance. You cannot gauge Strachey's services to science by the papers which he contributed to scientific societies, if you leave out of account the fact that they were really incidents in the opening of fresh channels of communication between scientific work and the public service.

And Eliot, as Meteorological Reporter to the Government of India, an accomplished mathematician (for he was second wrangler and first Smith's prizeman in 1869), a capable and devoted public servant, the medium by which Strachey's ideas as regards the use of meteorology in administration found expression in the Government of India, who caught the true perception of the place of science in the service of the State, and made his office the indispensable handmaid of the Indian administration. These three men together, who have all passed away within a space of three months, are such representative types of scientific workers, complementary and supplementary, that a similar combination is not likely to occur again. All three indispensable, yet no two alike, except in their enthusiasm for the sciences for the advancement of which Section A exists.

To these I might indeed add another type, the private contributor to the physical exploration of the visible universe, of which Ireland furnishes so many noble examples; and in that connection let me give expression to the sense of grievous loss, to this Association and to Science, occasioned by the premature death of W. E. Wilson, of Daramona, a splendid example of that type.

In the division of the work of advancing the sciences of mathematics and physics and their application to the service of mankind, I am reminded of Dryden's somewhat lopsided comparison of the relative influence of music and song in his Ode to St. Cecilia's Day. If I may be pardoned for comparing small things with great, the power of Timotheus' music over Alexander's moods was hardly less complete than Kelvin's power to touch every department of the working world with his genius. But I may remind you that, after a prolonged description of the tremendous influence of Timotheus upon the victorious hero, the poet deals in one stanza with his nominal subject:—

> "At last divine Cecilia came,
> Inventress of the vocal frame;
> The sweet enthusiast, from her sacred store,
> Enlarged the former narrow bounds
> . . . . . . .
> With nature's mother-wit, and arts unknown before.
>
> Let old Timotheus yield the prize,
> Or both divide the crown;
> He raised a mortal to the skies,
> She drew an angel down."

I doubt if any of my hearers who knew Strachey by sight would recognise in him the scientific reincarnation of St. Cecilia, but it is none the less true that he was pre-eminent among men in inventing the means of drawing angels down and using their service for the attuning of common life to a scientific standard. It may be equally hard for those who knew him to look upon Eliot as a vocal frame, for of all his physical capacities his voice was the least impressive; and yet it is not untrue to say that he was conspicuously a medium by which the celestial harmonies of the physical sciences were brought into touch with the practical life of India through his work, which is represented by a considerable number of the twenty volumes of Memoirs of the Indian Meteorological Service.

I do not indulge in this poetic extravagance without some underlying reason. Speaking for the physics of the atmosphere, there is a real distinction between these three sides of scientific work. To some is given the power of the mathematician or the physicist to raise the mortal to the skies, to solve some problem which, if not in itself a meteorological one, still has a bearing, sooner or later to be discovered and developed, upon the working of atmospheric phenomena. It is easy enough to cite illustrious examples: among notable instances there recur to my mind Rayleigh's work on the colour of the sky and Pernter's meteorological optics; papers by Ferrel and others on the general circulation of the atmosphere; Kelvin and Rayleigh on the elastic oscillations of the atmosphere; the papers by Hagen, Helmholtz, Oberbeck, Margules, Hertz, and Von Bezold on the dynamics and thermodynamics of the atmosphere, collected and translated by Cleveland Abbe; the work on atmospheric absorption by Langley and the theoretical papers on radiation by Poynting; those on condensation nuclei by Aitken and Wilson, and the recent work on atmospheric electricity, including the remarkable paper by Wilson on the quiet transference of electricity from the air to the ground.

But these things are not of themselves applied to the meteorology of everyday life. It is, in a way, a separate sense, given to few, to realise the possibilities that may result from the solution of new theoretical problems, from the invention of new methods—to grasp, in fact, the idea of bringing the angels down. And, in order that the regular workers in such matters may be in a position constantly to reap the advantages which men of genius provide, the vocal frame must have its permanent embodiment. For the advancement of science in this sense we require all three—the professor with academic freedom to illuminate with his genius any phenomenon which he may be pleased to investigate, the administrator, face to face with the practical problems in which science can help, and the living voice which can tune itself in harmony with the advances of science and in sympathy with the needs of the people whom it serves.

The true relations of these matters are not always apparent. Eliot, bringing to the work of the Indian Meteorological Office a mind trained in the mathematical school of which Kelvin was a most conspicuous exponent, achieved a remarkable success, with which perhaps my hearers are not familiar.

In this country there is a widespread idea that meteorology achieves its object if by its means the daily papers can give such trustworthy advice as will enable a cautious man to decide whether to take out his walking-stick or his umbrella. Some of us are accustomed to look upon India as a place of unusual scientific enlightenment, where governments have a worthy appreciation of the claims of science for recognition and support. But Eliot was never tired of telling me that it was the administration of India, and not the advancement of science, that the Indian administrators had in view; and among his achievements the one of which he was most proud was that the conduct of his office upon scientific lines during his tenure had so commended itself to the administrators that his successor was to be allowed three assistants, with special scientific training, in order that the State might have the benefit of their knowledge.

It is, of course, easy to suggest in explanation of this success that the Department of Public Works of India cannot afford to be unmindful of the distribution of rainfall, and that there is an obvious connection between Indian finances and Indian droughts; but it is a new fact in British history that the application of scientific considerations to the phenomena of rainfall is of such direct practical importance that meteorological information is a matter of consequence to all Government officials, and that meteorological prospects are a factor of finance. Imagine his Majesty's Chancellor of the Exchequer calling at 63 Victoria Street to make inquiries with a view to framing his next Budget, or taking his prospects of a realised surplus from the Daily Weather Report. Yet in India meteorology is to such an extent a public servant that such proceedings would not excite remark.

To have placed a scientific service on such a footing is, indeed, a notable success. Again, I rely upon Eliot when I say that that success is only to be achieved by being constantly on the watch to render service wherever service can be rendered. There is a difference between this attitude and that which has for its object the contribution of an effective paper to a scientific publication; in other words, it must be frankly recognised that the business of the scientific departments of government is not to raise an occasional mortal to the skies, but to draw down as many angels as are within reach. I was much surprised, when Eliot wished to develop a large scheme for meteorological work on a wider scale, that he made his appeal to the British Association as Chairman of the Sub-section for Cosmical Physics at Cambridge, and thereby to the Governments of this country and the Colonies. He felt that he could only urge the Indian Government to join, and he did so successfully, so far as India would be directly benefited thereby, however important the results might be from a purely scientific point of view. Strange as it may appear to some, it was to this country that he looked for assistance, on the plea of the increase of knowledge for its own sake, or for the sake of mankind at large.

I am disposed, therefore, to carry your thoughts a little further, and rely on your patience while I consider another aspect for the process of drawing down the angels from the mathematical and physical sky, a process which is sufficiently indicative of the functions of a State scientific department. Viewing the world at large, and not merely that part of it with which we are ourselves immediately concerned, such departments deal with celestial physics in astronomy, with the physics of the air in meteorology and atmospheric electricity, with the physics of land and water in physical geography and geology, seismology and terrestrial magnetism, oceanography and hydrography. It is for the practical applications of these sciences to the service of the navigator, the fisherman, the husbandman, the miner, the medical man, the engineer, and the general public that there is an obvious public want.

Let me carry you with me in regarding these departments, primarily, as centres for establishing the growth of science by bringing it to bear upon the practical business of life, by a process of regular plantation, and not the occasional importation of an exotic scientific expert. I shall carry you with me also if I say that the gravest danger to such scientific institutions is the tendency to waste. I use the term "waste" not in its narrowest but in its most liberal sense, to include waste of money, waste of effort, waste of scientific opportunity. I do not regard it as a waste that such a department should be unable to emulate Timotheus' efforts. Any aspiration in that direction is, of course, worthy of every encouragement, but the environment is not generally suitable for such achievements. I do, however, regard it as waste if the divine Cecilia is not properly honoured, and if advantage is not taken of the fullest and freest use of the newest and best scientific methods, and their application in the widest manner possible.

I speak for the Office with which I am connected when I say its temptations to waste are very numerous and very serious. It is wasteful to collect observations which will never be used; it is equally wasteful to decline to collect observations which in the future may prove to be of vital importance. It is wasteful to discuss observations that are made with inadequate appliances; it is equally wasteful to allow observations to accumulate in useless heaps because you are not sure that the instruments are good enough. It is wasteful to use antiquated methods of computation or discussion; it is equally wasteful to use all the time in making trial of new methods. It is wasteful to make use of researches if they are inaccurate; it is equally wasteful to neglect the results of researches because you have not made up your mind whether they are accurate or not. It is wasteful to work with an inadequate system in such matters as synoptic meteorology; it is equally wasteful to lose heart because you cannot get all the facilities which you feel the occasion demands.

It is the business of those responsible for the administration of such an office to keep a nice balance of adjustment between the different sides of activity, so that in the long run the waste is reduced to a minimum. There must in any case be a good deal of routine work which is drudgery; and if one is to look at all beyond the public requirements and public appreciation of the immediate present, there must be a certain amount of enterprise and consequently a certain amount of speculation.

Let me remark by the way that there is a tendency among some of my meteorological friends to consider that a meteorological establishment can be regarded as alive, and even in good health, if it keeps up its regular output of observations in proper order and up to date, and that initiative in discussing the observations is exclusively the duty of a central office. That is a view that I should like to see changed. I do not wish to sacrifice my own privilege of initiative in meteorological speculation, but I have no wish for a monopoly. To me, I confess, the speculation which may be dignified by the name of meteorological research is the part of the office work which makes the drudgery of routine tolerable. For my part I should like every worker in the Office, no matter how humble his position may be, somehow or other to have the opportunity of realising that he is taking part in the unravelling of the mysteries of the weather; and I do not think that any establishment, or section of an establishment, that depends upon science can be regarded as really alive unless it feels itself in active touch with that speculation which results in the advancement of knowledge. I do not hesitate to apply to other meteorological establishments, and indeed to all scientific institutions that claim an interest in meteorology, the same criterion of life that I apply to my own office. It is contained in the answer to the question, How do you show your interest in the advancement of our knowledge of the atmosphere? The reply that such and such volumes of data and mean values measure the contribution to the stock of knowledge leaves me rather cold and unimpressed.

But to return to the endeavour after the delicate adjustment between speculation and routine, which will reduce the waste of such an institution to a minimum; experience very soon teaches certain rules.

I have said elsewhere that the peculiarity of meteorological work is that an investigator is always dependent upon other people's observations; his own are only applicable in so far as they are compared with those of others. Up to the present time, I have never known anyone take up an investigation that involved a reference to accumulated data without his being hampered and harassed by uncertainties that might have been resolved if they had been taken in time. I shall give you an example presently, but, in the meantime, experience of that kind is so universal that it has now become with us a primary rule that any data collected shall forthwith be critically examined and so far dealt with as to make sure that they are available for scientific purposes—that is, for the purposes of comparison. A second rule is that as public evidence of the completion of this most important task there shall be at least a line of summary in a published report, or a point on a published map, as a primary representation of the results. Such publication is not to be regarded as the ultimate application of the observations, but it is evidence that the observations are there, and are ready for use.

You will find, if you inquire, that at the Office we have been gradually lining up these troops of meteorological data into due order, with all their buttons on, until, from the commencement of this year, anyone who wishes to do so can hold a general review of the whole meteorological army, in printed order—first-order stations, second-order stations, rainfall stations, sunshine and wind stations, sea temperatures and other marine observations—on his own study table, within six months of the date of the observations, upon paying to his Majesty's Stationery Office the modest sum of four shillings and sixpence. For all the publications except one the interval between observation and publication is only six weeks, and as that one has overtaken four years of arrears within the last four years, I trust that by the end of this year six weeks will be the full measure of the interval between observation and publication in all departments. This satisfactory state of affairs you owe to the indefatigable care and skill of Captain Hepworth, Mr. Lempfert, and Mr. R. H. Curtis, and the members of the staff of the Office who work under their superintendence. I need say little about corresponding work in connection with the Daily Weather Report, in which Mr. Brodie is my chief assistant, although it has received and is receiving a great deal of attention. The promptitude with which the daily work is dealt with hardly needs remark from me, though I know the difficulties of it as well as anyone. If I spend only one long sentence in mentioning that on July 1, 1908, the morning hour of observation at twenty-seven out of the full number of twenty-nine stations in the British Isles was changed from 8 a.m. to 7 a.m., and the corresponding post-offices, as well as the Meteorological Office, opened at 7.15 a.m. in order to deal with them, so that we may have a strictly synchronous international system for Western and Central Europe, and thus realise the aspiration of many years, you will not misunderstand me to mean that I estimate the task as an easy one.

The third general rule is that the effectiveness of the data of all kinds, thus collected and ordered, should be tested by the prosecution of some inquiry which makes use of them in summary or in detail. It is here that the stimulating force of speculative inquiry comes in; and it is in the selection and prosecution of these inquiries, which test not only the adequacy and effectiveness of the data collected, but also the efficiency of the Office as contributing to the advance of knowledge, that the most serious responsibility falls upon the administrators of Parliamentary funds.

Scientific Shylocks are not the least exacting of the tribe, and there have been times when I have thought I caught the rumination:—

> *Shy.* Three thousand ducats? 'tis a good round sum!
> *Bas.* For the which, as I told you, Antonio shall be bound.
>
> . . . . . . .
>
> *Shy.* Antonio is a good man?
> *Bas.* Have you heard any imputation to the contrary?
> *Shy.* No! no, no, no, no. . . . Yet his means are in supposition: he hath an argosy bound to Tripolis, another to the Indies; I understand moreover, upon the Rialto, that he hath a third in Mexico, a fourth for England, and other ventures he hath squandered abroad. But ships are but boards, sailors but men. There is the peril of water, winds, and rocks. . . . Three thousand ducats.

We at the Meteorological Office are very much in Antonio's position. Our means of research are very much in supposition: four observatories and more than four hundred stations of one sort or another in the British Isles; an elaborate installation of wind-measuring apparatus at Holyhead; besides other ventures squandered abroad; an anemometer at Gibraltar, another at St. Helena; a sunshine recorder at the Falkland Isles, half a dozen sets of instruments in British New Guinea, and a couple of hundred on the wide sea. The efforts seem so disconnected that the rumination about the ducats is not unnatural.

And you must remember that we lack an inestimable advantage that belongs to a physical laboratory or a school of mathematics, where the question of the equivalent number of ducats does not arise in quite the same way. The relative disadvantage that I speak of is that in an office the allowance for the use of time and material in practice and training disappears. All the world seems to agree that time or money spent on teaching or learning is well spent. In the course of twenty years' experience at a physical laboratory, and in examinations not a few, I have seen $\mathfrak{M}$ and $\mathfrak{H}$ or the wave-length of sodium light determined in ways that would earn very few ducats on the principle of payment by results; but, having regard to the psychological effect upon the culprit or the examiner, the question of ducats never came in. Wisely or unwisely public opinion has been educated to regard the psychological effect as of infinite value compared with the immediate result obtained. But in an office the marks that an observer or computer gets for showing that he "knew how to do it," when he did not succeed in doing it, do not count towards a "first class," and we have to abide by what we do; we cannot rely on what we might have done. Consequently our means in supposition, spread over sea and land, are matters of real solicitude. In such circumstances there might be reason for despondency if one were dependent merely upon one's own ventures and the results achieved thereby. But when one has the advantage of the gradual development of investigations of long standing, it is possible to maintain a show of cheerfulness. When Shylock demands his pound of flesh in the form of an annual report, it is not at all uncommon to find that some argosy that started on its voyage long ago "hath richly come to harbour suddenly." There have been quite a number of such happy arrivals within the last few years.

I will refer quite briefly to the interesting relations between the yield of barley and cool summers, or the yield of wheat and dry autumns, and the antecedent yield of eleven years before, which fell out of the body of statistics collected in the Weekly Weather Report since 1878. The accomplished statisticians of the Board of Agriculture have made this work the starting-point for a general investigation of the relation between the weather and the crops which cannot fail to have important practical bearings.

Let me take another example. For more than a full generation meteorological work has been hampered by the want of a definite understanding as to the real meaning in velocity, or force, of the various points of the scale of wind-estimates laid down in 1805 by Admiral Beaufort for use at sea, and still handed on as an oral tradition. The prolonged inquiry, which goes back really to the report upon the Beckley anemograph already referred to, issued quite unexpectedly in the simple result that the curve

$$p = 0{\cdot}0105B^3$$

(where $p$ is the force in pounds per square foot, and B the arbitrary Beaufort number) runs practically through nine out of the eleven points on a diagram representing the empirical results of a very elaborate investigation. The empirical determinations upon which it is based are certainly not of the highest order of accuracy; they rely upon two separate investigations besides the statistical comparison, viz., the constant of an anemometer and the relation of wind-velocity to wind-pressure, but no subsequent adjustment of these determinations is at all likely to be outside the limits of an error of an estimate of wind-force; and the equation can be used, quite reasonably, as a substitute for the original specification of the Beaufort scale, a specification that has vanished with the passing of ships of the type by which it was defined. This result, combined with the equation $p = 0{\cdot}003V^2$, which has been in use in the Office for many years, and has recently been confirmed as sufficiently accurate for all practical purposes by Dr. Stanton at the National Physical Laboratory and Monsieur Eiffel at the Eiffel Tower, places us upon a new plane with regard to the whole subject of wind-measurement and wind-estimation.

Results equally remarkable appear in other lines of investigation. Let me take the relation of observed wind velocity to barometric gradient. You may be aware that in actual experience the observed direction of the wind is more or less along the isobars, with the low pressure on the left of the moving air in the northern hemisphere; and that crowded isobars mean strong winds. Investigations upon this matter go back to the earliest days of the Office.

There can be no doubt that the relation, vague as it sometimes appears to be upon a weather chart, is attributable to the effect of the earth's rotation. In order to bring the observed wind velocity into numerical relation with the pressure-gradient Guldberg and Mohn assumed a coefficient of surface "friction," interfering with the steady motion. The introduction of this new quantity, not otherwise determinable, left us in doubt as to how far the relation between wind and pressure distribution, deducible from the assumption of steady motion, could be regarded as a really effective hypothesis for meteorological purposes.

Recent investigations in the Office of the kinematics of the air in travelling storms, carried out with Mr. Lempfert's assistance, have shown that, so far as one can speak of the velocity of wind at all—that is to say, disregarding the transient variations of velocity of short period and dealing with the average hourly velocity, the velocity of the wind in all ordinary circumstances is effectively steady in regard to the accelerating forces to which it is subject. This view is supported by two conclusions which Mr. Gold has formulated in the course of considering the observations of wind velocity in the upper air, obtained in recent investigations with kites. The first conclusion is that the actual velocity of wind in the upper air agrees with the velocity calculated from the pressure distribution to a degree of accuracy which is remarkable, considering the uncertainties of both measurements; and the second conclusion affords a simple, and I believe practically new, explanation upon a dynamical basis of the marked difference between the observed winds in the central portions of cyclones and anti-cyclones respectively, by showing that, on the hypothesis of steady motion, the difference of sign of the effective acceleration, due to curvature of path and to the earth's rotation respectively, leads to quite a small velocity and small gradient as the limiting values of those quantities near anti-cyclonic centres.

This conclusion is so obviously borne out by the facts that we are now practically in a position to go forward with the considerable simplification which results from regarding the steady state of motion in which pressure gradient is balanced by the effective acceleration due to the rotation of the earth and the curvature of the path, as the normal or ordinary state of the atmosphere.

I cannot forbear to add one more instance of an argosy which has richly come to harbour so lately as this summer. You may be aware that Kelvin was of opinion that the method of harmonic analysis was likely to prove a very powerful engine for dealing with the complexities of meteorological phenomena, as it has, in fact, dealt with those of tides. In this view Sir Richard Strachey and the Meteorological Council concurred, and an harmonic analyser was installed in the Office in 1879, but subsequently numerical calculation was used instead. A considerable amount of labour has been spent over the computation of Fourier coefficients. Not many great generalisations have flowed from this method up to the present time. I have no doubt that there is much to be done in the way of classifying temperature conditions, for climatic purposes, by the analysis of the seasonal variations. A beginning was made in a paper which was brought to the notice of the Association at Glasgow. The most striking result of the Fourier analysis we owe to Hann, who has shown that, if we confine our attention to the second Fourier coefficient of the diurnal variation of pressure—that is, to the component of twelve-hour period—we get a variation very marked in inter-tropical regions, and gradually diminishing poleward in both hemispheres, but synchronous in phase throughout the 360 degrees of a meridian. The maximum occurs along all meridians in turn about 10 a.m. and 10 p.m. local time. This semi-diurnal variation with its regular recurrence is well known to mariners, and we have recently detected it, true to its proper phase, in the observations at the winter quarters of the *Discovery*; small in amplitude indeed—about a thousandth of an inch of mercury—but certainly identifiable.

The reality of this variation of pressure, common to the whole earth, cannot be doubted, and, so far as it goes, we may represent it (if indeed we may represent pressure differences as differences in vertical heights of atmosphere) as the deformation of a spherical atmosphere into an ellipsoid, with its longest axis in the Equator pointing permanently 30° to the west of the sun. Its shortest axis would also be in the Equator, and its middle axis would be along the polar axis of the earth. Somehow or other this protuberance remains fixed in direction with regard to the sun, while the solid earth revolves beneath it. Whatever may be the cause of this effect, obviously cosmical, and attributable to the sun, at which it indirectly points, its existence has long been recognised, and further investigation only confirms the generalisation. It is now accepted as one of the fundamental general facts of meteorology.

Prof. Schuster, for whose absence from this meeting I may venture to express a regret which will be unanimous, has already contributed a paper to the Royal Society pointing out the possible relations between the diurnal variations of pressure and those of terrestrial magnetic force. Going back again to the ubiquity of the application of the relation of pressure and wind, in accordance with the dynamical explanation of Buys Ballot's law, we should expect the effect of a pressure variation that has its counterpart in that of terrestrial magnetism to be traceable also in wind observations.

Mr. J. S. Dines has just given me particulars of the discovery of that effect in the great air-current, the variations of which I have called the pulse of the atmospheric circulation—I mean the south-east Trade Wind, the most persistent atmospheric current in the world. It is difficult as a rule to get observers to pay much attention to that current, because it is so steady; but in 1891 the Meteorological Council set up an anemometer at St. Helena, in the very heart of the current, and we have just got out the results of the hourly tabulations. When the observations for the hours 1 to 24 are grouped separately for months, so as to give the vector resultants for each hour and for each month, it appears that there is a conspicuous semi-diurnal variation in the current, which shows itself as a closed polygon of vector variations from the mean of the day.

The month of April gives the most striking diagram of the twelve. It displays the superposition of two practically complete dodekagons, one a large one, completing its cycle from 6 a.m. to 6 p.m., the other a small one, for 6 p.m. to 6 a.m. The resultant wind for the whole day is very nearly south-east, and practically remains so for all the months of the year, the monthly variation of resultant wind being confined to a change of velocity from about fourteen miles per hour in May to about twenty-one miles per hour in September.

If, instead of combining the south and east components to form a vector diagram, we plot their variations separately, the semi-diurnal variation in each is plainly marked; and the calculation of its constants shows that its amplitude is about three-quarters of a mile per hour both in the south and rather less in the east component. The easterly increment has its maxima at 10 a.m. and 10 p.m., and at these hours the phase of the variation of the southerly component is nearly opposite. Thus, to correspond with the semi-diurnal variation of pressure, there is a semi-diurnal variation in the Trade Wind at St. Helena, which is equivalent to the superposition upon the resultant wind of a north-easterly component of about one mile per hour amplitude, with maxima at 10 a.m. and 10 p.m., the hours when the ellipsoidal deformation of the spherical atmosphere is passing over the locality.

I have only dealt with one month. I believe that when all the results that flow from this simple statement can be put before you, you will agree with me that the argosy which the Meteorological Council sent out in 1891 has indeed richly come to harbour.

Let me digress to say a word in illustration of the principle I laid down that, if one would avoid waste in meteorological work, the observations must be examined forthwith and so far discussed that any ambiguities may be cleared up.

After some years of wear at St. Helena the persistent rubbing of the south-east part of the spiral metallic pencil upon the metallic paper wore away the metal and left a flat place. This got so bad that the instrument had to come home for repairs, and when it was set up again, after a year's absence, the average direction of the Trade Wind differed by two points from the averages of most, but not of all, of the previous years. So far as we know, the orientation has been attended to, as before, and yet it is hardly possible to resist the suggestion that the anemometer has been set slightly differently. We are now making very careful inquiries from the observer; but, in the meantime, it seems to me that there is a great opportunity for a competent mathematical physicist to help us. Dynamical explanations of the Trade Winds have been given from the time of Halley. Let me offer as a simple question in the mathematical physics of the atmosphere whether a variation of two points in the direction of the south-east Trade Wind between the years 1903 and 1905 can be regarded as real, and, if not, which of the two recorded directions is the correct one?

It would be appropriate for me to add some words about the results of last year's work upon the upper air, in which we have had the valuable cooperation of the University of Manchester. These results have disclosed a number of points of unusual interest. But we are to have an opportunity of considering that subject in a discussion before the Section, and I need not deal with it here. I must, however, pause to give expression of the thanks of all meteorologists to Prof. Schuster for his support of the Manchester University station at Glossop Moor. I may remind you that this generous contribution for the advancement of science on the part of Prof. Schuster is in addition to the foundation of a readership in mathematical physics at Manchester and a readership in dynamical meteorology, now held by Mr. Gold at Cambridge.

I have said enough to show that the speculative ventures of official meteorologists are not all failures, and I will only add that if any mathematician or physicist would like to take his luck on a meteorological argosy he will be heartily welcomed. Part of the work will be drudgery; he must be prepared to face that; but the prospects of reaching port are reasonably good, so much so, indeed, that such a voyage might fairly lead to a claim for one of the higher academical degrees.

Up to now I have been dealing with the adjustment of official scientific work to reduce waste to a minimum, in so far as it lies within the control of those responsible for an office. I turn now to an aspect of the matter in which we require the assistance of others, particularly of the British Association.

The most serious danger of waste in a busy office is that it should carry on its work without an adequate knowledge of what is being done in advancing science and improving methods elsewhere. I speak myself for the Meteorological

Office alone, but I believe that the responsible officials of any scientific Government department will agree with what I say.

Year by year some Timotheus "with his sounding flute and tuneful lyre" performs some miracle by the application of reasoning to the phenomena of Nature. Only last year you heard Prof. Love in his presidential address treat of the mundane question of the shape of the earth and etherealise the grim actualities with the magic of his spherical harmonics. Year by year, in every one of the subjects in which the practical world is immediately interested, active students, whether public officials, academic officials, or private enthusiasts, not only keep alight the sacred flame but occasionally add to its brilliance; and all the new knowledge, from whencesoever it comes, ought to be applied to the service of the State.

The actual volume of original contributions on these subjects is by no means inconsiderable. You are all aware that, some years ago, the Royal Society initiated a great international enterprise for the compilation of a catalogue of scientific literature. I have been looking at the fifth annual issue of the volume on meteorology, including terrestrial magnetism. I may remark that the catalogue is quite incomprehensibly eclectic as regards official literature, but let that pass. I find that, in the year that closed with July, 1907, 1042 authors (not counting offices and institutions as such) presented to the world 2131 papers on meteorology, 229 on atmospheric electricity, and 180 on terrestrial magnetism. This will give some idea of the annual growth in these subjects, and may convince you that, after all allowance is made for duplicate titles, for papers of no importance, and for mere sheets of figures published for purposes of reference, there remains a bulk of literature too large for any single individual to cope with if he has anything else to do.

If instead of confining ourselves to what can be included in meteorology alone we extend our view over the other allied sciences, it would be necessary to take in other volumes of the international catalogue, and there would be some overlapping. I have taken instead the volume of the "Fortschritte der Physik" for 1906, which deals with "Kosmische Physik." It is edited by Prof. Assmann, who adds to his distinction as head of the Royal Prussian Aëronautical Observatory of Lindenberg that of an accomplished bibliographer. In this volume are given abstracts or titles of the papers published during the year which can be regarded as worthy of the attention of a physicist. An examination of the volume gives the following numbers of the papers in the different sections:—

| | | Papers |
|---|---|---|
| Astro-Physics ... ... ... ... ... | | 222 |
| Meteorology ... ... ... ... ... | | 1122 |
| Atmospheric Electricity ... ... ... ... | | 135 |
| Geophysics: | | |
| Geodetics ... ... ... ... | 105 | |
| Seismology and Volcanic Phenomena | 256 | |
| Terrestrial Magnetism and Aurora ... | 108 | |
| Currents, Tides, and Waves... ... | 46 | |
| Inland Hydrography ... ... ... | 117 | |
| Ice, Glaciers, and Ice Age ... ... | 139 | |
| Other papers ... ... ... ... | 126 | |
| | — | 897 |
| Total ... ... ... | | 2376 |

I need hardly say that these 2376 papers are not all English; in some of the sections few of them are in that language, and fewer still are British. If British students, official and unofficial, are to make the most of the operation of drawing the angels down, they need help and co-operation in dealing with this mass of literature, in winnowing the important from the unimportant, and in assimilating that which makes for the real progress of the practical application of science. This is the more necessary for these subjects because there is no organised system of academic teaching, with its attendant system of text-books. In a subject which has many university teachers it might reasonably be supposed that any important contribution would find its way into the text-books, which are constantly revised for the use of students; and yet in his presidential address to the Royal Society in November of last year, Lord Rayleigh felt constrained to point out that, for the advance of science, although the main requirement is original work of a high standard, that alone is not sufficient. "The advances made must be secured, and this can hardly be unless they are appreciated by the scientific public." He adds that "the history of science shows that important original work is liable to be overlooked and is, perhaps, the more liable the higher the degree of originality. The names of T. Young, Mayer, Carnot, Waterston, and B. Stewart will suggest themselves to the physicist, and in other branches, doubtless, similar lists might be made of workers whose labours remained neglected for a shorter or longer time."

If this is true of physics how deplorably true it is of meteorology. If I allow a liberal discount of more than 50 per cent. from the numbers that I have given, and estimate the number of effective contributions to meteorology as recognised by the "International Catalogue" at a thousand, which agrees pretty well with that given by the "Fortschritte der Physik," and if I were to ask round this room the number of these papers read by anyone here present, I am afraid the result would be disheartening. Many of us have views as to the way in which the study of meteorology ought to be pursued, but the views are not always based on an exhaustive examination of the writings of meteorologists. Few of us could give, I think, any reasonable idea of the way in which it is being pursued by the various institutions devoted to its application, and of the progress which is being secured therein. Meteorological papers are written by the hundred, and whether they are important or unimportant, they often disregard what has been already written in the same or some other language, and are themselves in turn disregarded. I do not think I should be doing any injustice if I applied similar remarks to some of the other subjects included in the table which I have quoted. How many readers are there in this country for an author in terrestrial magnetism, atmospheric electricity, limnology, or physical oceanography? But, if the papers are not read and assimilated, the advancement of science is not achieved, however original the researches may be.

By way of remedy for the neglect of important papers in physics, Lord Rayleigh suggests that teachers of authority, who, from advancing years or from some other reason, find themselves unable to do much more work in the direction of making original contributions, should make a point of helping to spread the knowledge of the work done by others. But what of those subjects in which there are no recognised teachers? and in this country this is practically the case with the subjects which I have mentioned. It is true that many of them are made the occasion of international assemblies, at which delegates or representatives meet. But such international assemblies are of necessity devoted, for the most part, to the elaboration of the details of international organisation, and not to the discussion of scientific achievements. The numbers attending are, equally of necessity, very restricted.

The want of opportunity for the discussion of progress in these sciences is specially lamentable, because in its absence they lose the valuable assistance of amateur workers, who might be an effective substitute for the students of an academic study. In no subject are there more volunteers, who take an active part in observing, than in meteorology; but how few of them carry their work beyond the stage of recording observations and taking means. The reason is not lightly to be assigned to their want of capacity to carry on an investigation, but far more, I believe, to the want of knowledge of the objects of investigation and of the means of pursuing them.

Among the agencies which in the past have fostered the knowledge of these subjects, and stimulated its pursuit, there stand out prominently the annual meetings of this association. It was the British Association which in 1842 re-founded the Kew Observatory for the study of the physics of the atmosphere, the earth, and the sun. It was the British Association which promoted the establishment of magnetic observatories in many parts of the earth, and in the early 'sixties secured the most brilliant achievements in the investigation of the atmosphere by means of balloons. I know of no other opportunity of anything like the same potentialities for the writers of papers to meet with the readers, and to confer together about the progress of the sciences in which they are interested. But its potentialities are not realised. Those of us who are most anxious for the spread of the application of mathematics and physics to the phenomena of astronomy, meteorology, and geophysics have thought that this opportunity could not properly be utilised by crowding together all the papers that deal with such subjects into one day, or possibly two days, so that they can be polished off with the rapidity of an oriental execution. In fact, the opportunity to be polished off is precisely not the opportunity that is wanted. There are some of us who think that a British Association week is not too long for the consideration of the subjects of which a year's abstracts occupy a volume of six hundred pages, and that, if we could extend the opportunity for the consideration of these questions from one or two days to a week, and let those members who are interested form a separate committee to develop and extend these subjects, the British Association, the country, and science would all gain thereby. I venture from this place, in the name of the advancement of science, to make an appeal for the favourable consideration of this suggestion. It is not based upon the depreciation, but upon the highest appreciation of the service which mathematics and physics have rendered, and can still render, to the observational sciences, and upon the well-tried principle that close family ties are strengthened, and not weakened, by making allowance for natural development.

The plea seems to me so natural, and the alternatives so detrimental to the advancement of science in this country, that I cannot believe the Association will turn to it a deaf ear.

## NOTES.

We deeply regret to have to announce the death, at the age of seventy-one, of M. E. E. Mascart.

We much regret to have to record the death of the Earl of Rosse, F.R.S., which took place on Saturday last.

The death is announced of Mr. F. Kynaston Barnes, formerly assistant constructor of the Navy and surveyor of dockyards. He was the author of many papers in the Transactions of the Institution of Naval Architects, joint author, with Prof. Rankin, of "Shipbuilding," and joint editor for a number of years, with Lord Brassey, of "The Naval Annual." Mr. Barnes, who at the time of his death was in his eighty-first year, was the inventor of the present method of calculating the stability of ships, which is known as "Barnes's method," and was the designer of the *Nile* and the *Trafalgar*.

The death is announced of M. J. F. Nery Delgado, president of the Geological Survey of Portugal. M. Nery Delgado was also inspector-general of mines and a member of the Lisbon Royal Academy of Sciences.

The death is announced of Mr. James D. Hague, the eminent American mining geologist, at the age of seventy-two. He became manager of the Lake Superior copper mines in 1863, and participated in the early development of the Calumet and Hecla mine. His most important work was his report on the mining industry of the fortieth parallel, published in 1870.

A citizens' committee has been formed to arrange for the entertainment of the British Association in Canada next year, and various Western Governments and cities will be requested to cooperate. The programme, so far, provides for a trip through the west, and one through the mountains to the Pacific coast. Transportation facilities are being arranged, and a number of distinguished guests from Canada and the United States will be invited. Provision will also be made for a limited number of ladies.

According to the *Times*, the Liverpool School of Tropical Medicine is making arrangements to send an expedition to Jamaica to investigate tropical diseases there and the insect life of the island, which is responsible for carrying disease. It is intended to send Mr. Robert Newstead, the lecturer in economic entomology and parasitology of the Liverpool School of Tropical Medicine, in the first week of November to undertake the investigation of the ticks there responsible for certain diseases in animals, and of disease-bearing insects. It is possible that he may be accompanied by a medical research investigator, whose duties would be to investigate indigenous diseases of the island.

A Reuter message from Simla, dated August 28, states that the servant of Dr. Sven Hedin has reached Leh, Kashmir, reporting that the explorer was four marches from Gartok twenty-five days before, and was in good health. A message from the *Times* correspondent at Simla, dated August 31, reports that Dr. Sven Hedin is expected at Simla next week. A letter dated Gartok, August 1, is the first direct news heard from the explorer for several months.

It is stated in *Science* that the department of meridian astrometry of the Carnegie Institution, in charge of Prof. Lewis Boss, of the Dudley Observatory at Albany, N.Y., where the work of the department is carried on, is dispatching an expedition to the Argentine Republic to establish a branch observatory there. This observatory will be established at San Luis, about 500 miles west from Buenos Aires. This town, of about 10,000 inhabitants, is located near the eastern edge of the Andean plateau at an elevation of about 2500 feet. It is reported to have a fine climate with remarkably clear skies. The principal instrument will be the Olcott meridian circle of the Dudley Observatory, which will be set up in its new location for the purpose of making reciprocal observations upon stars already observed at Albany, together with observations upon all stars from south declination to the south pole that are brighter than the seventh magnitude, or which are included in Lacaille's survey of the southern stars made at the Cape of Good Hope in 1750. It is estimated that the work of observation in Argentina will last three or four years. The object of these observations is to gather material for facilitating the construction of a general catalogue of about 25,000 stars, in which will be contained accurately computed positions and motions of all the stars included in it.

According to a Reuter message from Berlin, a wireless telegram has been received from the steamer *Kaiserin Auguste Victoria* stating that Dr. Polis, the director of the meteorological observatory at Aachen, is continuing his experiments in transmitting meteorological observations at sea between New York and England by means of wireless telegraphy. Dr. Polis is reported to have succeeded in receiving weather reports from America at a distance of 800 nautical miles from the American coast, while reports from Europe were picked up at a distance of 1200 nautical miles from the English coast. Daily weather charts were drawn up by using reports from passing ships, which indicated the state of the weather on the Atlantic Ocean over an extent of 800 nautical miles. A message sent on August 27 to the *Kaiserin Auguste Victoria* from Aachen, *via* Ireland, took three hours to reach the ship.

The summary of the weather for the closing week of August issued by the Meteorological Office shows that the rainfall was everywhere largely in excess of the average, the total for the week exceeding 2 inches in several districts, and amounting to 2·30 inches in the south-west of England. Over the western portion of the kingdom, as well as in the south of England, rain fell each day. The mean temperature was nowhere very different from the average, and notwithstanding the heavy rain there was a slight excess of bright sunshine. The aggregate rainfall for the summer, as comprised by the thirteen weeks ending August 29, was everywhere in defect of the average except in the south and north-west of England. In the east of Scotland, the north-east of England, the south of Ireland, and in the Channel Islands the deficiency of rain was more than 2 inches. The rainy days were also deficient, except in the north of Scotland, where there was a deficiency of bright sunshine, all other districts showing a larger amount of sunshine than usual. In London, June was the only summer month with a deficiency of rain, and the total excess for the three months is 0·6 inch, the aggregate measurement being 7·14 inches; the wettest month was July, with a rainfall measuring 3·42 inches.

MAJOR W. A. J. O'MEARA, R.E., C.M.G., has been appointed by the President of the Board of Trade an additional British delegate to the International Conference on Electrical Units and Standards, which is to meet in London on October 12 next.

PROF. C. O. WHITMAN, who has for the past twenty years been director of the Marine Biological Laboratory, Wood's Hole, Mass., has resigned that position, and the assistant director, Prof. F. R. Lillie, of the University of Chicago, has been elected in his stead.

AT the celebration of the jubilee of the British Ornithologists' Union, which is to take place in London in December next, gold medals will be presented to each of the four original members—Dr. F. Du Cane Godman, F.R.S., Mr. P. S. Godman, Mr. W. H. Hudleston, F.R.S., and Dr. P. L. Sclater, F.R.S.

HIS MAJESTY THE KING has accorded his patronage to the Royal Society of Medicine, and has intimated his intention to sign the roll of the society in the autumn. During the past three months the Society of Anæsthetists and the Society for the Study of Disease in Children have joined the Royal Society of Medicine as sections for the study of the subjects in which they are especially interested.

THE fifty-third annual exhibition of the Royal Photographic Society of Great Britain will be held in London from September 17 to October 24.

ACCORDING to *Science*, the assistants of Prof. Novarro, of Genoa, have decided to endow a Novarro prize to be awarded for work in general pathology.

NOTICE is given by the council of the Royal Society of Arts that the next award of the Swiney prize (consisting of a cup of the value of 100*l*. and money to the same amount) will be awarded in January next. The award will be for a work on medical jurisprudence. Any person desiring to submit a work in competition, or to recommend any work for the consideration of the judges, should do so by letter, addressed to the secretary of the Royal Society of Arts.

THE New York Academy of Medicine offers a prize of 200*l*. for the best essay on "The Etiology, Pathology, and Treatment of the Diseases of the Kidney." The papers submitted must reach the academy on or before October 1, 1909.

THE Academy of Sciences of Stockholm has undertaken the publication of the scientific works of Swedenborg, and vol. i. of the series, dealing with geology, and containing a number of Swedenborg's letters, has recently been issued. Vol. ii. will contain treatises on chemistry, physics, and mechanics, and vol. iii. treatises on cosmology. Four further volumes are planned, and will deal respectively with the brain and general physiology.

THE provisional programme of the Incorporated Institution of Automobile Engineers for the session 1908–9 has been issued, and comprises the following items:—On October 14 the presidential address by Mr. Dugald Clerk, on some problems of the motor-car; on November 11 a paper by Mr. B. Hopkinson, on a complete test of a modern petrol engine—power, thermal and mechanical efficiency, exhaust products at various powers and speeds; and on December 9 a paper entitled "How the Weight of the Motor-car is made up" will be read by Mr. Mervyn O'Gorman. The following papers and discussions have been arranged for the general meetings of the institution in 1909:—Mr. F. H. Royce, causes of wear in motor machinery; Mr. G. H. Baillie, carburettor experiments; Mr. Horatio Ballantyne, the chemistry of petrol; Mr. Bertram Blount, on specifying the quality of petrol; Mr. F. R. S. Bircham, the use of small internal combustion engines for marine work; Mr. L. A. Legros, transmission; Mr. E. H. Cozens-Hardy, motor cabs; Dr. W. Watson, F.R.S., petrol engine experiments; and a discussion on valve setting, introduced by Mr. Max R. Lawrence.

A RECENTLY issued consular report from Tahiti states that among the innovations in agriculture to which the soil of some of the uninhabited valley lands of Tahiti and of other neighbouring islands would be propitious is the planting of rubber, which, it is believed, would give excellent results. The variety which appears to be specially recommended for the valleys of Tahiti is the *Castilloa elastica*, which has been experimented upon on a small scale with such encouraging results that a local company has been floated for the purpose of planting rubber on an extensive scale.

A DESCRIPTIVE account of the new aëroplane of Mr. Henry Farman appears in *La Nature*, and is abstracted by the Paris correspondent of the *Times*. The apparatus differs entirely in construction from Mr. Farman's two previous machines. Instead of having double planes, connected by ties and stays, which are regarded as offering undue resistance to the air, the new machine has, on either side, three wing-like single planes, giving it the appearance which has suggested its name—the *Flying Fish*. The body, made of ash, has, indeed, the exact shape of a long and slender fish, tapering backwards with a gentle dropping curve. It is 46 feet long, square in section, and comes somewhat sharply to a point in front, where a plate of aluminium supports the shaft of the propeller. Its four members are connected by wooden ties and steel stays, producing a girder of perfect rigidity. The machine is mounted on two wheels placed well forward under the motor. The steel framework which carries these wheels, as well as that of a third wheel placed near the tail, is provided with strong spiral springs intended to reduce the shock of alighting on the ground. The six rectangular "wings" are fixed towards the head of the machine, and are each 8 feet $8\frac{1}{4}$ inches long and 1 foot $3\frac{1}{2}$ inches wide. They consist of wooden frames rising towards the extremity, slightly curved and tapering on the same lines as the body of the "fish" itself. They are covered by a double layer of thin fabric. The second plane on each side is placed somewhat lower than the first, and the third somewhat lower than the second. At the tail are two similar but rather shorter planes, the hindermost of which is movable on its axis, and acts as a horizontal rudder for regulating the height of flight. At the end of all comes the vertical cellular rudder of direction. It is mounted on a pivot fixed in the solid wooden shoe, which terminates the body of the machine, and it is prolonged forward over the back of the "fish" for nearly half the total length by a triangular extension of the same material as the planes. The whole body is covered with material, but in front of the pilot's position sheets of mica take the place of the stuff, so that his view may not be obstructed. The total bearing surface is 24 square metres. A novelty has been introduced into the steering apparatus. The wheel, which resembles that of a motor-car, is mounted vertically and acts normally upon the vertical rudder of direction, but when moved horizontally it acts by means of a lever on the horizontal rudder. The *Flying Fish* is fitted with a new 35-horse-power motor, especially constructed by the Renault Company. This motor has eight cylinders, arranged in a V, is air-cooled by two fans, and weighs 130 kilograms. There is an aluminium carburettor and a diminutive magneto. The motor is connected directly with the two-bladed propeller. The whole aëroplane, including the pilot, weighs 650 kilograms.

To the August number of the *Contemporary Review* Dr. Alfred Russel Wallace has contributed a fighting article on the present position of Darwinism, in which it is urged that neo-Lamarckism, the mutation theory of de Vries, and Mendelism in no wise affect the truth and stability of the natural-selection doctrine. Neo-Lamarckism is dismissed with the statement that since, according to Mr. W. L. Tower, there is no evidence "to show the inheritance of acquired somatic characters or their incorporation in the germ-plasm," the fundamental assumption of the theory is false. As regards the mutation-doctrine, it is pointed out that whereas sudden structural "jumps" are common among cultivated plants and domesticated animals, in wild nature they are exceedingly rare, and would inevitably be speedily swamped in the course of evolution. This implies the existence in cultivation and domestication of some "provocative" factor which is lacking, or latent, in nature, and this, again, strikes at the root of the Mendelian doctrine as explanatory of the origin of species. "The claims of the Mutationists and Mendelians," writes Dr. Wallace in unequivocal language, "as made by many of their ill-informed supporters, are ludicrous in their exaggeration and total misapprehension of the problem they profess to have solved." On the other hand, it is admitted by the critic that Mendelism may, and probably will, have a certain value in explaining the transmission of disease and other matters connected with heredity.

"THE Rate of Growth of the Reef-building Corals" forms the title of a small pamphlet, by Mr. F. Wood Jones, published by Messrs. John Bale, Sons and Danielsson, Ltd., of Oxford House, Great Titchfield Street. These notes, which were made during a fifteen months' residence on the Keeling-Cocos Atoll, claim to have put the evidence as to the rate of coral-growth in a more definite form than has hitherto been the case. It is pointed out that, in order to be of value, observations must extend over a long period, as corals are subject to great seasonal and individual variation in their rate of increase, while there is likewise great difference in this respect between the branching and the massive groups. On the average, it appears that branching corals grow about 3·7 inches in a twelvemonth, while the massive species increase their diameter by about 1/37 of their original circumference in 100 days. In other words, a coral 37 inches in diameter will measure 38 inches across in a little more than three months. An estimate of the rate of growth of the branching species made by Dr. Guppy is practically identical with the author's results.

THE nature and causes of dwarf faunas are discussed at some length by Prof. H. W. Shimer in the July issue of the *American Naturalist*. Instances are given of the occurrence of such dwarfed invertebrate aquatic faunas in several parts of the world, while extinct faunas of the same type are likewise noticed. The chief agency in their production seems to be variation of environment, such as a large infusion of fresh water into a more or less isolated sea. Two types of dwarf faunas occur, one in which the individuals of different species are smaller than the normal, and the other in which individuals are normal, but all the species are small owing to the weeding-out of the larger ones. Dwarfing may show itself by the premature development of senile features or by the retention of juvenile characteristics (owing to slow development) throughout life.

CAPTAIN STANLEY FLOWER, in a very interesting article published in the *Zoologist* for August, discusses the ordinary prices paid to dealers for various species of wild animals (inclusive of mammals, birds, and reptiles). The prices quoted are restricted to transactions which have taken place during the last dozen years, and are solely based on the author's personal experiences. The highest-priced animal mentioned in the list is the giraffe, which ten years ago could not be purchased for 1000*l*., although its value has now fallen to 400*l*. or 500*l*. We believe, however, that equally high prices have been paid for rhinoceroses. On the other hand, for its size, the brown bear is one of the cheapest of all wild animals, a specimen having changed hands for 4*l*. We should like to know the estimated value of a living sea-otter.

A NOTE on the utilisation of the "khair" forests in eastern Bengal and Assam has been published as Forest Pamphlet No. 1 issued by the Government of India. The author, Mr. P. Singh, adduces evidence for disregarding the belief that the wood of the "khair" tree, *Acacia catechu*, is devoid of catechin when it grows in moist localities. He also indicates the methods for preparing the dye-material cutch and for extracting the catechin in the preparation of "katha" or "kath," a product that finds favour among the native population as a chewing substance.

AT the meeting of the American Philosophical Society held at Philadelphia in April, Mr. J. W. Harshberger read a paper on the leaf structure of the sand-dune plants of Bermuda. On the upper beach *Cakile aequalis* is a characteristic plant, and *Ipomoea pes-caprae* is luxuriant. Associated with the latter on the dunes are *Scaevola Plumieri*, *Tournefortia gnaphalodes*, and *Juniperus bermudiana*. *Conocarpus erectus* and *Stenotaphrum americanum* also grow on the dune slopes. Various devices for preventing undue loss of water are described. *Sisyrinchium bermudianum* bears the stomata in deep cavities, in the leaves of *Lantana involucrata* they lie in depressions fringed with hairs; Conocarpus secretes gum in the cells, and *Borrichia arborescens* depends upon a dense covering of hairs. The paper is printed in the first quarterly number of this year's Proceedings.

THE fortieth volume of Engler's "Botanische Jahrbücher," beginning with a part published in May, 1907, was concluded with the fifth part, published in May last.

Two fascicles of the contributions to the flora of Africa are included in the volume, in which the most general article is a revision of the African genera and species of the order Flacourtiaceæ, that has been prepared by Dr. E. Gilg. A phytogeographical study based on an exploration of the mid-Amazon is presented by Mr. E. Ule. The expedition, primarily undertaken to obtain information with regard to rubber trees and their distribution, has yielded much botanical treasure, and the author gives an elaborate description of the floras of the various tributaries. In the pages of the "Beiblätter" will be found the proceedings of the Society of Systematic Botanists at their meetings in Hamburg (1906) and Dresden (1907). An important paper was read at the Dresden meeting by Prof. O. Drude on mapping methods in connection with botanical surveys. Colours are used for certain broad, distinctive formations, such as moors and swamps or coniferous forest; on these are superposed special signs and letter combinations indicative of plant associations.

Under the title of "Classification palethnologique," the eminent French anthropologist, M. A. de Mortillet, publishes a pamphlet intended to provide a scheme for the seriation of early art from prehistoric times down to the age of Charlemagne. His plan of grouping is founded on typical specimens, the terminology being based on the names of those Continental sites at which the most characteristic examples have been discovered. The prehistoric period, or age of Stone, falls into three subgroups:—Éolithique, including Thenaysien and Puycournien; Paléolithique, with its subdivisions, Chelléen, Acheuléen, Moustérien, Solutréen, and Magdalénien; Néolithique, confined to Robenhausien. Similarly, the protohistoric time divides itself into an age of Bronze and of Iron, the former represented by the Tziganien period subdivided into the Morgien and the Larnaudien. The age of Iron falls into three periods, Gaulois, Romain, and Mérovingien, the first divided into Hallstattien and Marnien, the second into Lugdunien and Champdolien, the third including Wabénien. Each period is illustrated by excellent drawings of typical specimens, with descriptions and details of provenance. The scheme will be of much use in classifying the objects of human art in Continental museums, to which the survey is largely confined.

Two important communications on the subject of stone implements appear in *Man* for July and August. In the earlier number the Rev. H. G. O. Kendall describes a collection of Neolithic microliths from Welwyn, in Hertfordshire, and other sites in the Quaternary gravels of Essex. Many of the specimens are carefully chipped, and were probably used as boring tools. Those at Welwyn were found at a depth of 12 feet in some thin layers of gravelly sand. They seem to be analogous to the so-called "pygmy" flints discovered by Mr. R. A. Gatty at Scunthorpe, in Lincolnshire, which were described in *Man* (February, 1902), and closely resemble specimens found by Mr. A. C. Carlleyle in the Indian Vindhya range. In the August number of the same periodical Mr. C. G. Seligmann describes a collection of quartz implements from Ceylon, found in various parts of the island in sites varying from a height of a few hundred feet above sea-level to about 4000 feet. The range of their distribution indicates that at one time there must have been a considerable population using tools of this kind. They are found in places at present occupied by the Veddahs, and Mr. Seligmann accepts the view of the brothers Sarrasin that they may be attributed to this race. The caves in which they were discovered seem to have been seized by the Sinhalese some two thousand years ago, when they expelled the Veddah occupants. In later days the Veddahs re-occupied these sites. These recent discoveries seem to indicate a closer connection between the two races than is usually realised.

The report on the work of the Survey Department, Egypt, in 1907, shows that good progress is being made in the various branches of its useful and far-reaching operations. Among these are included, *inter alia*, (1) the topographical survey comprising the 1 : 10,000, 1 : 50,000, and 1 : 250,000 series of maps; (2) the cadastral survey, which prepares maps on large scales, showing property boundaries and the land registers which accompany them. These sheets are utilised for the production of maps on smaller scales, but since the country is changing very rapidly in parts, owing to perennial irrigation, barrage, and reclamation, the cadastral sheets have usually to be revised in the field. (3) The geological survey; Captain Lyons states that during the past ten seasons' work the general outline of the geological structure of the country has been laid down in considerable detail, and that a geological map of the country on the scale of 1 : 1,000,000 is now in hand. In addition, the department tests the gas and water supplies of Cairo, and analyses materials supplied to various departments to see if they are in conformity with specification; it also superintends the meteorological stations in Egypt and the Sudan, and the preparation of observations for publication. We notice several important additions to the meteorological work, *e.g.* the publication of daily synoptic charts for the Mediterranean and adjacent parts (to which we have before referred), the discussion and immediate utilisation of observations made in Cyprus (by arrangement with the Meteorological Committee), and the exploration of the upper air. Although the latter service was only begun in July, 1907, some very valuable results have already been obtained.

We have received for notice eight further volumes of the water supply and irrigation papers issued by the Department of the United States Geological Survey. These relate to the geology and water resources of districts along the Mississippi and Hudson Bay, in California, north-west of the Pacific, Nebraska, and Beaver Valley, Utah. The information contained is comprehensive and useful locally, but there is nothing of a special character that calls for further notice here. The methods of gauging the streams and the instruments employed, which are described and illustrated, have been already dealt with in previous articles.

In the July number of the *National Geographic Magazine* Mr. A. H. Sylvester, of the United States Geological Survey, gives an interesting account, illustrated by admirable photographs, of "our noblest volcano," Mount Hood, which rises to a height of 11,225 feet in the State of Oregon. It is an almost perfect volcanic cone, the fourth in height of the snow peaks of the Pacific North-West, being surpassed only by Rainier, Shasta, and Adams. It was built up of andesitic lavas which were ejected from a single summit crater. Recently the volcano has displayed signs of renewed activity. Prof. Russell, in his book on "American Volcanoes," gave a picture taken in 1882 of a so-called fumarole on the south slope, which has since that time apparently become inactive; but steam has recently been observed to issue from fissures on Crater Rock, and something resembling a glow was noticed at the same point in 1907. It is interesting to note that this activity was synchronous with changes observed in the Bogaslof group of volcanic islands off the Alaskan coast.

The *Rivista Geografica Italiana*, No. 6 of 1908, contains a short note on the remarkable eruption of Etna on April 29 last. This was preceded by violent earthquakes, and accompanied by the opening of a fracture of more than a kilometre in length and from 20 to 50 metres in breadth. Several parasitic cones of small size were formed along it, and about 500,000 cubic metres of lava poured out, but the fissure was only partially obscured by erupted material, and remained conspicuous after the eruption had ceased. Although this eruption was violent while it lasted, and although the interval separating it from the next preceding eruption was more than fifteen years, or about two and a half times the average during the last 150 years, the eruption was of very short duration, commencing at 5.20 a.m. on April 29 and ceasing at 5.40 p.m. on April 30, but practically lasting for only about seventeen hours.

The report of the Meteorological Committee for the year ending March 31 last contains much useful reading for those interested in the development of meteorological science, and shows that great efforts are being made both from practical and theoretical points of view. Many useful publications have been issued during the year, to some of which we have already referred; among those still in the press we may specially mention:—(1) meteorological results for the western portion of the Atlantic anticyclone, by Dr. R. H. Scott; (2) seasons in the British Isles since 1878; and (3) summary of hourly values at four observatories, 1870–1908. The most important point to be noted in connection with the periodical publications is the revision of the form of the monthly weather report, which gives summaries from all stations in connection with the office, either directly or through the meteorological societies and other bodies, and includes a rainfall map contributed by Dr. H. R. Mill. This change is based on the principle that the value of the observations is much enhanced by prompt publication, and now extends to all branches of the work; *e.g.* the marine department, under the able superintendence of Commander Hepworth, issues elaborate monthly pilot charts for the Atlantic and Indian Oceans, which include the latest intelligence of use to seamen received by cable from the Canadian and Indian Meteorological Services. In view of the importance of a homogeneous system of weather telegraphy in western Europe, the committee has changed the hour of reports from 8h. to 7h. a.m.; the additional expense of the earlier opening of the telegraph offices gives rise, however, to a serious question of ways and means. The use of wireless telegrams and the investigation of the upper air are among the many other important matters engaging the earnest attention of the committee.

The June number of *Terrestrial Magnetism and Atmospheric Electricity* contains a short article on the work of the magnetic survey yacht *Galilee* from the pen of the director, Dr. L. A. Bauer. During the three years' voyages of the *Galilee* a complete magnetic survey of the Pacific Ocean was made with scarcely a hitch in the programme originally sketched out for it. The experience gained on board has led to the conclusion that for future work a vessel must be specially constructed, and the Carnegie Institution has undertaken to defray the cost of a new wooden sailing vessel, the *Carnegie*, 155 feet long, with auxiliary power (125 horse-power) provided by a gas engine, built, so far as possible, of non-magnetic materials, so that the outstanding magnetic effect of the ship will be less than the errors of observation. It is hoped that the ship will be ready next year, when a survey of the Atlantic will be commenced.

In a further article in the same magazine Dr. Bauer points out that the recent attempts to represent the magnetic state of the earth by means of spherical harmonics have not led to results of which any practical use can be made, owing to the wide divergence between the calculated and the observed values for any point. This he puts down to the distribution of areas of irregularity of varied amounts and extents over the earth, and the difficulty of representing their effects analytically without calculating a prohibitive number of terms. He concludes that the time has come to halt in our attempts to calculate more terms, and to fix on a small number as representing the principal features of the magnetic state of the earth with sufficient accuracy, and to deal with each of the residuals separately.

## OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in September:—

Sept. 7. Venus. Illuminated portion of disc = 0·431; 27th = 0·568.
9. 7h. 56m. to 8h. 56m. Moon occults $\tau^2$ Aquarii (mag. 4·3).
10. 16h. 9m. to 16h. 56m. Moon occults 30 Piscium (mag. 4·7).
11. 7h. 45m. Saturn in conjunction with Moon (Saturn 2° 33′ N.).
13. 11h. 42m. Minimum of Algol ($\beta$ Persei).
14. 9h. Venus at greatest elongation (46° 2′ W.).
15. 13h. 37m. to 14h. 40m. Moon occults $\epsilon$ Tauri (mag 3·7).
,, Saturn. Outer minor axis of outer ring = 5″·32.
16. 8h. 31m. Minimum of Algol ($\beta$ Persei).
,, 16h. 12m. to 17h. 29m. Moon occults $o$ Tauri (mag. 4·8).
20. 19h. Venus in conjunction with Moon (Venus 5° 0′ S.)
22. 12h. 19m. Jupiter in conjunction with Moon (Jupiter 3° 45′ S.).
,, 22h. 59m. Sun enters Libra; Autumn commences.
29. 19h. Saturn in opposition to the Sun.

Observation of Phœbe, Saturn's Ninth Satellite.—From a note in No. 4270 of the *Astronomische Nachrichten* (p. 362, August 21) we learn that photographs of Saturn's ninth satellite, Phœbe, were obtained at Greenwich, with the 30-inch reflector, on July 31, August 1, 2, and 3. Provisional measures of the position-angle and distance of the satellite, about 63° and 30′ respectively, are given for each date. On August 3 the satellite was at, or very near, eastern elongation, so that these positions, in combination with those determined at western elongation about October 30, 1907, will furnish valuable data for the determination of the mass of Saturn.

The Parallax of 61 Cygni.—From meridian observations, made with the small meridian-circle of the Astronomical Institute of Heidelberg Observatory, Herr Giorgio Abetti has determined the parallax of the well-known double star 61 Cygni, and publishes a preliminary communication of his results in No. 4270 of the *Astronomische Nachrichten*. These preliminary results give a somewhat lower value than previous determinations, the respective parallaxes of the preceding and following components being $+0''{\cdot}24 \pm 0''{\cdot}05$ and $+0''{\cdot}22 \pm 0''{\cdot}05$.

Prominences at the Sun's Poles.—In No. 7, vol. xxxvii., of the *Memorie della Società degli Spettroscopisti Italiani* (p. 107) Father Fenyi discusses, at some length, the occurrence and appearance of large prominences near the solar poles. The discussion embraces the question as to the epoch of the sun-spot period at which such prominences are most frequently seen, and it is shown that their maximum takes place some months after the sun-spot maximum. Among other conclusions, Father Fenyi finds that there is a periodical sharp maximum to which it is desirable that further attention should be paid. He also shows that the estimation of the heliographic latitude of the sun's polar cap from the continuous observations of the positions of prominences in regard to the limb is not satisfactory, as a prominence 60″ in height will remain visible and simply appear to oscillate during a whole rotation. It is suggested, however, that satisfactory determinations of the polar rotation in high latitudes could be made by observing these prominences, whereas the sun-spot observation method cannot be applied and the spectroscopic method is unsatisfactory.

OBSERVATIONS OF VARIABLE STARS.—The periods and light-changes of several variable stars are discussed in Bulletins Nos. 15 and 16 of the Laws Observatory, University of Missouri. No. 15 is devoted to the discussion of 395 observations of the Algol variable RW Monocerotis (24, 1907) made during the period October, 1907, to April, 1908, and a period of 1·9 d. is deduced, the light-changes taking place in 7h. 34m.

The observations of the long-period Algol variable RZ Ophiuchi are discussed in Bulletin No. 16, and a period of 261·8 d. is found to satisfy them. The other variables, for which only preliminary announcements are given, are RS Boötis, 43.1907 Draconis, 44.1907 Ursæ Majoris, and SW Andromedæ (5, 1907).

THE INFLUENCE OF THE EARTH'S ROTATION ON THE COURSES OF RIVERS.—In a paper published in the Transactions of the New Zealand Institute (vol. xxxix., pp. 207–213) Dr. F. W. Hilgendorf discusses some very careful observations made by himself of the possible influence of the earth's rotation on the course of the rivers which flow over the Canterbury Plains, New Zealand. These plains, being of a very homogeneous structure, afford an excellent site for the testing of "Ferrel's law" concerning the deflecting force of the earth's rotation, and Dr. Hilgendorf succeeds in showing that this deflecting force has, in all probability, been an effective factor in the modification of the banks of the rivers which flow in a N.E.–S.W. direction across the Canterbury plains.

A POSSIBLY UNDISCOVERED FORM OF SOLAR RADIATION.—In No. 5 of the *Comptes rendus* (p. 318, vol. cxlvii., August 3) M. E. Durand-Gréville discussed the secondary twilight and dawn which are observed in the Alps and at other great altitudes, and suggested that reflection of the sunlight from the temperature-reversing layer of the atmosphere, discovered by M. Teisserenc de Bort, might account for these phenomena; but in No. 7 of the *Comptes rendus* (August 17) M. Deslandres offers an alternative suggestion. It is that, in addition to the solar radiations which traverse our atmosphere and those ultra-violet radiations which are known to be absorbed by it, there may be others, in the further ultra-violet, to which the atmosphere may be transparent or which are able to produce a phosphorescence which would account for the secondary illumination of the mountain sides, &c., after the passing of the ordinary twilight. He further suggests a method whereby the existence of such radiations may be demonstrated.

## WELSH ASTRONOMICAL TRADITIONS.

I HAVE put together some notes, compiled out of the flotsam and jetsam of Welsh tradition bearing on the continuity of the astronomy of the stone monuments, with the view of finding out how far such traditional materials will enable us to reconstruct, with the aid of the testimony of the monuments themselves, the story of the megalithic period in Britain, the period or periods of the avenue, circle, and cromlech.

### *The Testimony of the Bards.*

I have already in these columns claimed for the Gorsedd a continuity of bardic tradition of the greatest value. A more careful study of isolated bardic utterances shows us the bard-astronomer at work in the same capacity as the priest-astronomer of the megalithic period.

There are two utterances attributed to the bard Taliesin which strongly suggest the use of stars as heralds of sunrise or as clock stars. In such utterances the note of antiquity is the bard's assumption of exclusive knowledge of astronomical phenomena. He challenges others to tell him "what hour in the small of the day (meinddydd) that Cwy was born?" Who Cwy was I know not, but the expression should be remembered in discussing Welsh solar heroes. Again, the bard speaks contemptuously of some who "do not know the point of separation between dewaint (the midnight watch, 1 to 3) and gwawr (dawn)."

It should be remembered that the body of tradition we are discussing was once common to the inhabitants of Wales as Goidelic or Irish before it became Welsh. The Irish bard Amairgen speaks still more definitely of his indispensableness:—

> "Who foretells the ages of the moon (but I)?
> Who teaches the spot where the sun rests (but I)?"

The sun rests at the solstice. People from the earliest times would have noted as much. But the spot—who but the bard knew the solstitial alignment? The words take us back not only to a period before the popular use of a calendar, but also to the time when the almanac for the year was fixed by direct observation of the solstice sun on the horizon; not that observation of the solstice along the horizon is in itself a proof of antiquity, for a farmer in the parish from which I write still uses that ancient method; but what is curious is the bard's assumption of exclusive credit for the information.

The leading astronomers of bardic tradition are mythical personages. I have elsewhere shown how the leading saints of Wales were regarded as astronomers. But the leading astronomers were the associates of gods, if not gods themselves. "The three sublime astronomers of the Isle of Britain:—Idris the Giant, Gwydion the son of Don, and Gwyn the son of Nudd. So great was their knowledge of the stars, and of their nature and situation, that they could foretell whatever might be desired to be known to the day of doom."

Idris is commemorated in the name of the Merionethshire mountain, Cadair Idris (Idris's Chair). The Milky Way is called Caer Gwydion (Gwydion's Encampment). His mother was a goddess. Gwyn, the son of Nudd, is spoken of as the King of the Fairies. His father seems to have been the Welsh Neptune.

So the remotest antiquity and the place of highest importance is given to astronomy in Welsh or British tradition.

### *Holed Stones.*

These are rather rare monuments. I have notes of some in Wales, and I expect, with the growth of interest in the astronomical study of such monuments, that more will be brought to light. As Cornish and Scottish tradition shows, such stones were used as charms, a fact which largely explains their present rarity.

I have not been able to find out the origin of a familiar Cardiganshire expression. When one makes a vain attempt to make another person understand or heed what is told him, the speaker or a friend makes the remark. "You might as well say Carreg a Thwll (Stone and Hole) to him." This cryptical Welsh expression is the name of the famous holed stone of Cornwall, Men-an-Tol, so that the Welsh colloquial Carreg a Thwll may reasonably be supposed to be the holed stone of the megalithic period.

A holed stone figures prominently in one of our oldest written tales, namely, the tale of Math, son of Mathonwy. The stone was on the bank of the river Cynvael in Ardudwy, a part of Merionethshire, and it was called Llech Gronw, "the Stone of Gronw or Goronwy." Gronw loved, and was loved by, the wife of Llew Llew Gyffes, "Llew of the Un-erring Hand." The woman induced her husband to tell her how he might be slain, pretending the most affectionate concern in such an event. He told her gladly, "Not easily can I be slain, except by a wound. And the spear wherewith I am struck must be a year in the forming. And nothing must be done towards it except during the sacrifice on Sundays. I cannot be slain within a house, nor without. I cannot be slain on horseback nor on foot." "Verily," said she, "in what manner then canst thou be slain?" "I will tell thee," said he. "By making a bath for me by the side of the river, and by putting a roof over the cauldron, and thatching it well and tightly, and bringing a buck, and putting it besides the cauldron. Then if I place one foot on the buck's back, and the other on the edge of the cauldron, whosoever strikes me thus will cause my death."

The woman's paramour toiled for a whole year making the spear, and one day Llew was induced by his wife to stand in the position by the cauldron he had indicated. "Thereupon Gronw rose up from the hill which is called Bryn Cyfergyr, and he rested on one knee, and flung the poisoned dart and struck him (Llew) on the side, so that the shaft started out, but the head of the dart remained in." Llew was, as we would say, mortally wounded, but nobody dies in the Mabinogion tales. They simply become transformed. Llew reappeared to return exactly the same compliment to Gronw. The latter begged of Llew to allow a stone to be placed between him and the marksman. "Then Llew flung the dart at him, and it pierced the slab and went through Gronw likewise, so that it pierced through his back."

At first sight the whole story might be regarded as a clumsy attempt at explaining the holed stone and its name. But what of the very curious details of this fabulous Order of the Bath?

The following considerations offer themselves. The typical wizard in Welsh tradition orders his body to be buried neither within nor without the church. "Standing with one foot in the grave" is a familiar expression. The picture of a man standing with one foot on the cauldron and the other on a buck's back brings to my mind another legendary picture of a man visiting a cave, where hidden treasures lie, on a cow's back. It was necessary for him to enter into the cave and return without dismounting, and he was allowed to pick up as much of the treasure as he could grab at on that bovine ride. The two Welsh words "bwch," "buck," and "buwch," "cow," are similar enough to become confused in such tales.

I would assume that the holed stone Llech Gronw was a solstitial sight-line from a circle or cromlech to the point on the horizon where the marksman stood to throw the dart. Such a sight-line was of no use except once a year, as the sun would only call once a year at that point. The spear was a year in the making. Sundays may be regarded as the moon's quarters, and though a solstitial cromlech or alignment was of use only once a year, there is evidence of a weekly ceremony of some sort at such monuments. The "curate" in charge of an astronomical monument had, like other curates, his work to do all the year round.

A holed stone between a specified hill-point and a covered structure—we have here the complete apparatus for observation from an *allée couverte*. To the archæologist, however, the holed stone is now a telescope reversed—that is, it is of use not to observe sunrise so much as to find hidden parts of the original alignment. Sir Norman Lockyer, in "Stonehenge," has shown that "holed stones were arrangements for determining alignments," and he tells us how an ancient stone alignment was traced from a circle to holed stones at Tregaseal (p. 282).

The utility of the holed stone as a path-finder, so to speak, has been proved by Dr. Baudouin, in France. At the third "Prehistoric" congress of France last year (reported in NATURE, October 24, 1907, p. 649), he showed that "menhirs were indicators of megalithic sepultures." "By using two certain holed stones as indicators, he was enabled to discover an *allée couverte* which was buried under the soil, and had until then remained undiscovered. This 'find,' made with remarkable scientific precision, was received by numerous foreign congressists as a striking example of the value of a theory which many of them still ignore."

The best oral tradition of a cave with sleeping warriors guarding treasure I have been able to collect at first hand is widely known at Devil's Bridge, Cardiganshire. All the story, which I have dove-tailed out of five versions, would occupy more space than I can reasonably expect to have here. Though it is known that the cave is situate on a woody slope on the farm of Tynycastell on the south side of the river Rheidol, no one living has seen it. But tradition has it that the mouth of the cave is sometimes seen from some point on Penrhiw farm on the north or opposite side of the valley. If my recollection is correct, that farm is north-east, and on the sky-line, from the traditional site of the cave, and if a careful search were made for some alignment or indicator at Penrhiw, possibly the hidden cave might be re-discovered. At any rate, the fact that the mouth of the cave used to be seen from Penrhiw indicates that the cave was a summer solstice *allée couverte*. This is further confirmed by the tradition that the mouth of the cave was to be seen from Penrhiw only once a year. These inferences as to the solstitial use of the cave are amply confirmed by the most definite local tradition.

This was the cave where the visitor had to enter and leave on a cow's back. Another version has it that there were three steps into the cave. When the visitor stood on the first step, a sleeping warrior inside awoke; when he stood on the second step, the warrior laid his hand on his sword; and when he stood on the third, the warrior cut off with his sword the lighted head of the candle which the visitor held in his hand. Another version simply gives it that when the visitor entered a warrior awoke and asked, "A ddaeth y tri bore'n un?" (Have the three mornings become one?) For about five years I kept troubling our folklore authorities for an explanation of that strange question, and quite in vain. Sir Norman Lockyer solved the conundrum by return of post. The three mornings in one are the three days of the solstice, when the sun stands still, and because of that apparent stationariness the three days were reckoned as one.

I believe that the well-known tradition at Devil's Bridge of a demon or hero imprisoned in a rock is a part, if not the leading part, of the cave legend of Tynycastell close by. He is popularly believed to be working his way out of a rock a "fathom" deep with "an ounce hammer and a clog-nail," or, as a more degenerate tradition has it, "an ounce hammer and a carpet-tack."

So much about a living tradition of a solstitial cromlech in actual use, and a tradition which has apparently survived the cromlech itself. By the bye, the "cave" is never a tomb. Its occupants are always alive, alive not as mere ghosts. Mr. T. H. Thomas has observed that "wraiths of human guardians, or inhabitants, are rare about cromlechs, while they are remarkably numerous about tumuli." While the cromlech in most instances seems to have been converted into a tomb, it is interesting to note that its folklore associations must have become fixed before such a conversion, and agree with and elucidate the astronomical interpretation of the use of the cromlech.

JOHN GRIFFITH.

## THE PRAGUE EXHIBITION.

FOR commercial purposes, the kingdom of Bohemia is divided into five districts, each under an officially recognised chamber of commerce. The district of the Prague Chamber of Commerce is the largest and most important of these. It has a population of two millions, a third of the population of the kingdom, and includes many of the chief centres of industry. The organisation of the Jubilee Exhibition at Prague is due to the enterprise of the committee of the Prague Chamber of Commerce. From every point of view the exhibition is a success. It is attracting a daily attendance of from 10,000 to 60,000 persons, who come from all parts of the world. The exhibition occupies an enclosure in a beautiful, well-wooded park on the outskirts of the city. In the effective design and picturesque arrangement of its buildings it is a model of what such an exhibition should be.

As would be expected, the character of the exhibition is definitely commercial; but pure art is not entirely neglected, and the orchestral concerts of the Bohemian Philharmonic Association are of a high order. No fewer than eighteen imposing pavilions have been specially built, and in addition use is made of a permanent building, erected originally for the exhibition of 1891. These buildings are devoted to the City of Prague, the chamber of commerce, machinery, the cities of the district, ceramic and glass industries, schools, goldsmiths' work, food, metal work, leather industries, chemical industries, graphic arts, photography, commerce, and temporary exhibits. Speaking generally, the exhibits in all departments show a high standard of design, finish, and workmanship. In view of the fact that many of the industries mentioned have only been established in Bohemia in recent years, the high quality of the manufactures is certainly remarkable.

Not less remarkable is the increase in the amount of the manufactures. In 1891 one building was sufficient to include a representative exhibit of the manufactures of the district; now it is difficult to compress such an exhibit into nineteen buildings. Trade returns confirm the impression which this comparison suggests.

An inquiry naturally suggests itself into the causes of this development. Recent years have certainly seen a great awakening of national life in Bohemia, but this alone would not be sufficient to account for the commercial prosperity of the country. A better explanation is to be found in the system of technical education which is being successfully worked in Bohemia. The scope and character of this system is admirably displayed in a well-arranged exhibit. Undoubtedly the keynote of the system is "specialisation," a word which has no terrors for the Bohemian, who is surprised that the exhibits from some of the special schools—such, for example, as that from a school for training barbers—should cause amusement to the English visitor; but, nevertheless, the fundamental principle of the system seems to be sound. A boy's trade is fixed, and whether or not he is apprenticed, he is trained definitely for the selected trade, without too much insistence on theoretical principles. If the boy is apprenticed he is obliged to attend an industrial continuation school during his apprenticeship. In these schools there are from six to ten hours of instruction per week, the lessons being given in the afternoons or early in the evening and on Sunday mornings. The course lasts from two to four years. If the boy is not apprenticed he is able to attend one of the special schools (*Fachschulen*) in which courses are provided, definitely taking the place of the apprenticeship. The industries included in the scope of these schools are lace-making, wood-carving, carpentry, cabinet-making, textile industries, basket-making, iron and steel work, engineering, masonry, glass-making, hardware goods, electro-engineering, locksmiths, musical instruments, jewellery, precious stone setting, machine embroidery, watch-making, and gun-making.

Another interesting type of school is the general handicraft school, to which boys of twelve are admitted. The aim is to give the boys a better preparatory training for a trade than is possible in the ordinary elementary school. Great stress is laid on drawing, and the boys are given practical instruction in the preparation of materials for wood and metal work. An experiment on these lines is at present being conducted by the London County Council. There are also higher industrial schools for well-prepared pupils who require a higher training for art, chemical or textile industries, building or engineering. In the larger centres of population there are central industrial institutes, where work of the nature of research is carried on.

The Austrian system of technical education is of special interest at the present time, because there is undoubtedly a tendency in England towards a higher degree of specialisation in the work of technical schools. It is being realised that an efficient system of technical education cannot be organised by the erection all over the country of technical institutes of the same type, with similar classes and laboratories, staffed by the same type of teacher. Some years ago it was discovered that mathematics could be taught for the practical purposes of engineers in a practical way, without much insistence on abstract principles, and since then a good deal of thought has been given to the special educational requirements of the several industries. Moreover, the educative value of the technical processes themselves is being more fully recognised. Mr. W. R. Lethaby, professor of design at the Royal College of Art, in a paper read to the International Drawing Congress on August 3, deprecated the "elaborate approaches to a practical subject" at present in vogue. "The great end," he said, "was production, the great thing was the trade, the craft, and sufficient culture could be hung up to any sufficient trade. . . . All proper education was the opening up of a necessary and beneficent life occupation." This expresses in the clearest way the principle which appears to underlie the Austrian system of technical education. The principle may be stigmatised as utilitarian; but anyone who doubts the practical success of the system will be well advised to examine the exhibits at the Prague Exhibition. T. Ll. H.

## *THE IMPROVEMENT OF AGRICULTURAL PLANTS.*[1]

In the *Bulletin de la Société d'Encouragement pour l'Industrie nationale* for May, M. Schribaux gives an account of the methods adopted for obtaining new varieties of agricultural plants. These methods fall into three groups:—(1) careful watch is kept for "sports," *i.e.* for plants which, for no obvious reason, differ from the others; (2) variation is induced by altering the conditions of growth; (3) suitable plants are "crossed."

The first method is necessarily haphazard, since sports can obviously not be predicted; it has, however, proved very useful in the past, and has yielded many valuable varieties of potatoes, of fruit trees, &c. The second method promises very interesting results, for some plants respond quickly to changes in their surroundings. M. Schribaux sowed in a garden soil the seeds of the wild carrot, an annual with a woody root. In two generations a certain number had become biennials, with a fleshy root like the cultivated carrot. M. Blaringhem adopted quite a different method with maize. Plants were cut down just as the ear was beginning to develop, *i.e.* at the time of maximum vital activity; 76 per cent. of those surviving developed abnormally. Some were permanently altered; thus a late Pennsylvania maize was converted into an early variety.

Another instance of great practical importance is furnished by the vine. After struggling long and vainly against Phylloxera, the French vine-growers have made up their minds to live with it. M. Viala visited America and brought back some vines which had become so differentiated from those growing in France that they withstood the attacks of the pest. Unfortunately, they would not grow on calcareous soils, but became very chlorotic, and further search was made. Vines were in the end discovered capable of withstanding Phylloxera and of growing on calcareous soils; these have solved the problem for the French grower. Perhaps the case of the sugar-beet is most interesting. The grower requires roots containing a large percentage of sugar, a low proportion of the accompanying salts, and capable of resisting adverse conditions. The selection is made, in the first instance, on the basis of the sugar content. A large number of roots can be rejected by simple inspection, for high sugar content is correlated with certain external features; the other roots are examined chemically, since it is found that removal of a portion for this purpose does not interfere with subsequent growth. The very best are then cut up into a number of pieces to be grafted into other roots; they produce seed, which is sown, and yields roots for further selection. M. Schribaux states that a single root has yielded sixty-four pieces, each capable of producing seed! It is not surprising that the percentage of sugar has gone up from 11 per cent. in 1870 to 16 per cent. or 18 per cent. to-day.

There is evidence, however, that the process will not go on indefinitely, for roots containing more than 18 per cent. of sugar cease to vegetate properly. Sir W. T. Thiselton-Dyer discusses this aspect of the question in the Journal of the Board of Agriculture for April, taking the potato as an illustration. Like the sugar-beet, the potato has been the subject of continual selection, and the end result is a highly artificial tuber of great commercial value but difficult of cultivation. The practical man speaks of degeneration, but Thiselton-Dyer does not consider this to be the case. He points out that the potato has been induced to load itself with starch far in excess of any natural requirement of the plant, and suggests that too much is being demanded of the plant, and the machinery for the processes of growth has reached its breaking point. "We can control nature in altering the constitution of a plant; but eventually a barrier is reached beyond which it is impossible to go."

It is often found difficult to fix the new varieties obtained by selection. Even when asexual reproduction is possible, as in the case of trees and potatoes, the variation frequently does not remain permanent, and many promising varieties have disappeared. When reproduction is by seed

[1] (1) *Bull. de la Société d'Encouragement pour l'Industrie nationale*, May, 1908.
(2) *Journal of the Board of Agriculture* April, 1908.
(3) *Journal of Agriculture of South Australia*, January, 1908.

it is still more difficult to fix a variety; this is abundantly proved by the difficulty of improving wheat. A single ear is selected because it possesses some desirable property; the seed from it is sown; an ear is selected showing the same property, and the process is continued for several generations. "Pedigree" seed is thus obtained, but it rarely remains true; the farmer has to renew his stock periodically from the raiser, who keeps on the selection process. The work done on the selection of seed wheats at the Roseworthy Agricultural College is described in the Journal of Agriculture for South Australia; it is hoped in this way to obtain strains which will keep their character for two or three seasons, and prove much more profitable than the seed wheat now in use. There is no question that a good deal can be done by selection, especially in South Australia, where, we are told, little or no attention has been given to the matter, and the best grain is sometimes sold and the worst kept for seed. But it is now clear that the only safe method for the improvement of crops grown from seed is to breed on Mendelian lines, as Biffen is doing at Cambridge, and South Australia would do well to breed, as well as to select, seed wheat.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

Cambridge.—Mr. Robert Forsyth Scott, fellow and senior bursar, has been elected master of St. John's College in place of the late Rev. Dr. Charles Taylor.

Prof. D. J. Hamilton, F.R.S., has, in consequence of ill-health, resigned the chair of pathology in the University of Aberdeen to which he was appointed in 1882.

Mr. W. Galloway Duncan, of Dundee, has been appointed head of the Government Engineering School, Dacca, Bengal.

The Senate of the University of Bombay has, according to the Allahabad *Pioneer Mail*, decided to include a test in science for all candidates for a degree.

The jubilee of the University Museum at Oxford will be celebrated on October 8. Honorary degrees will be conferred upon Prof. Arrhenius and Dr. Vernon Harcourt, F.R.S., and a bust will be unveiled of Prof. W. F. R. Weldon, who died in April, 1906.

The Year-book of the Michigan College of Mines, 1907–8, shows that the college is better equipped and more prosperous than at any previous period since its foundation in 1885. There are now 253 students, their average age being 22½ years. The concentration of effort on training men for the field of mining, the situation of the college in the heart of the copper-mining region of Lake Superior, together with its special methods of instruction, have brought to the institution a large measure of success. Considerable range is allowed in selecting the courses or subjects which shall compose a particular student's curriculum, and the Record of Graduates, published as a separate pamphlet, giving their occupations, affords interesting evidence of the success attained.

It is now recognised that the teaching of hygiene and physical exercises to pupils in both primary and secondary schools is of equal importance to their education in other branches of knowledge. In primary schools it is of special importance, as the opportunity for games is often absent in large towns. For this reason the Board of Education makes a knowledge of the methods of teaching and the aims of physical education one of the necessary parts of the equipment of a primary-school teacher. With this qualification is associated the requirement of a knowledge of hygiene, particularly in relation to schools and school children. For the last ten years a systematic course for women has been carried on at the South-Western Polytechnic, Chelsea. This training has been so successful that the course, originally designed for two years, has developed now into one of three years. The governors of the Chelsea Polytechnic are now instituting a similar course for men, and for this purpose they have engaged a teacher of gymnastics on Ling's Swedish system. In the first instance a course of one year for men will be provided, and it is hoped to obtain students who have passed already two years in training colleges, as well as university graduates with an initial equipment of general and elementary scientific knowledge. Such students, after a year devoted mainly to the study of hygiene, physiology, gymnastic exercises, and the part of anatomy bearing on physical training with study of the theory of movements, should be in a position to take charge of physical education in schools and to take their proper positions as teachers of usual subjects.

## *SOCIETIES AND ACADEMIES.*

### London.

Royal Society, March 5.—"On the Nature of the Streamers in the Electric Spark." By Dr. S. R. **Milner.** Communicated by Prof. W. M. Hicks, F.R.S.

(1) The streamers in the inductive spark consist of metallic vapour, the atoms of which are charged, and the motion of the vapour towards the centre of the spark gap is mainly due to the action of the electric force of the spark on the charged atoms. The chief evidence in support of this consists in a number of photographs in which the streamers move back again towards the poles as the oscillating electric field of the spark reverses its direction.

(2) Very great differences were found in the appearances of the streamers which correspond to the different lines of the same metal. The streamers may be divided in this respect into three classes, between which there is in most sparks a sharp distinction.

(*a*) Blurred streamers, which are often partly masked by the whole spark gap being filled with their light. These invariably correspond to lines prominent in the arc. (*b*) Sharply defined streamers, which appear throughout the whole time during which the electrical discharge lasts. These correspond to pure spark lines, *i.e.* lines which are not present in the arc under ordinary conditions. (*c*) A third class of streamers show very brightly at the first oscillation, but fade away so rapidly that they appear for only one or two oscillations, even when the other lines, initially no brighter, show ten or twelve. These lines are very sensitive to the influence of self-induction in the circuit; they are very bright in the condensed spark without inductance, but disappear from the spectrum altogether when a moderate inductance is inserted.

By studying the duration of the lines in the inductionless spark, the difference between the three classes of streamers is found to be solely a question of the duration of the luminosities of the metallic lines to which they correspond, the arc lines having a long, the spark lines a short, and the "condensed spark" lines a very short, duration.

(3) No other difference than this one of the durations of the lines has been discovered in the character of the streamers. The photographs obtained show clearly that the velocities of the streamers corresponding to the different lines in the same spark are the same, in spite of the different character of the streamers.

April 30.—"The Supersaturation and Nuclear Condensation of certain Organic Vapours." By T. H. **Laby.** Communicated by Prof. J. J. Thomson, F.R.S.

(1) The least expansion, which causes condensation in air initially saturated with an organic vapour and ionised by Röntgen rays, has been determined for five esters, six acids (formic to iso-valeric), and iso-amyl alcohol.

(2) In the case of acetic acid the expansion required was greater for feeble Röntgen rays than for more intense ones.

(3) The supersaturation, S, existing at the end of each of the expansions mentioned in (1) has been calculated, and also for four alcohols and chloroform from Przibram's experiments.

(4) The acids are found to have the largest values of S and the alcohols the least. The isomers examined have the same value for S with one exception. In the case of the alcohols, ethyl to iso-amyl, a fairly regular decrease in S accompanies the addition of a $CH_2$ group.

(5) The existing theory of condensation on ionic nuclei has been given, values of S have been calculated from it, and compared with S deduced from the observed expansions. The agreement in the case of acetic, propionic, *n*-butyric, and iso-butyric acids, and methyl alcohol is very close.

(6) The expansion and supersaturation necessary for condensation on the natural nuclei have been determined for the same (dust-free) vapours. In the case of formic, acetic, and butyric acids a distinctly greater expansion is required to catch the natural nuclei than that required for the ionic nuclei produced by Röntgen rays.

(7) As the expansion was increased the number of drops usually increased continuously with it, so that the fog point was ill-defined, except in the case of tertiary amyl alcohol.

(8) Ethyl acetate, methyl butyrate, propyl acetate, acetic acid, and iso-amyl alcohol were found to condense for a smaller expansion on the positive nucleus than on the negative. Water is the only known substance for which the negative ionic nucleus is more efficient than the positive.

(9) On bubbling air through methyl, ethyl, and iso-amyl alcohols, ethyl acetate, propyl acetate, methyl butyrate, chloroform, and ethyl iodide they became negatively electrified. This was the sign of the electrification to be expected from Prof. Thomson's double layer theory of the relative efficiency of ionic nuclei. Acetic acid was not in agreement with the theory, for it became positively charged on bubbling.

PARIS.

**Academy of Sciences**, August 24.—M. Bouquet de la Grye in the chair.—A problem relating to the theory of orthogonal systems and to the method of the mobile trihedron: Gaston **Darboux.**—Methylation in the ethylene series from the point of view of volatility: Louis **Henry.** The replacement of the hydrogen atoms attached to carbon in ethylene glycol by the methyl group causes a lowering of the boiling point, although the replacement of the hydrogen atoms in ethylene has the contrary effect. This is probably due to the association of the molecules in the alcohols, the coefficient of association becoming less as the number of hydrogen atoms substituted is increased. The boiling point is raised when methyl groups are introduced into ethylene chloride, and the ethylene oxides behave in a similar manner.—Twilight illuminations: Ernest **Esclangon.** A discussion of the colour effects observed at Bordeaux during twilight, the causes of which still remain unexplained.—Observations of the sun made at the Observatory of Lyons during the second quarter of 1908: J. **Guillaume.** Observations were made on sixty-five days, and tables are given showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—The theory of asymptotic lines: A. **Demoulin.**—The zeros of the integrals of a class of differential equations: Georges **Rémoundos.**—The variation of two ruled surfaces: M. **Haag.**—Liquid helium: H. Kammerlingh **Onnes.** Details are given of the methods adopted for the liquefaction of 200 litres of helium on July 10. This experiment required the use of 75 litres of liquid air and 20 litres of liquid hydrogen. Owing to the extremely small capillarity of liquid helium, the surface of the liquid meets the side of the containing vessel like a knife blade, and the formation of the first quantity of liquid escaped observation. The helium remained in the liquid state for two hours; its density was 0·154, and its boiling point, determined with a helium thermometer, 4°·3. The critical temperature is probably about 5°, and the critical pressure not much above 2·3 atmospheres. The helium was not solidified when the pressure was reduced to less than 10 mm. of mercury.—The action of chloride of arsenic on cobalt: F. **Ducelliez.** This reaction gives rise to cobalt chloride, together with an arsenide of cobalt. At a temperature of 1000° C. $Co_2As_3$ is formed, at 600° C. to 800° C. CoAs, at about 450° C. the product is $Co_3As_4$: below 400° C. $CoAs_2$ is slowly formed.—The action of arsenic trichloride upon nickel and arseno-nickels: Em. **Vigouroux.** The arsenides $Ni_5As_2$, NiAs, and $NiAs_2$ were obtained by varying the conditions of the experiment.—The two methods of preparation of monomethylamine: Maurice **François.** In a previous paper the author has described a method of separating methylamine from small proportions of ammonia by means of yellow mercuric oxide. To prepare the pure amine by this process it is requisite that ammonia should be the sole impurity, and the present paper gives a comparative study of the methods of Hoffmann (bromine and acetamide) and Brochet and Cambier (ammonium chloride and formaldehyde) from this point of view. The methylamine hydrochloride prepared by the latter method proved to be very impure; but the product of Hoffmann's reaction was quite suitable for further purification by mercuric oxide.—The mode of growth of the Morille (*Morchella semilibera*): Louis **Matruchot.**—The influences of the external conditions on the development and sexuality of the prothallus of Polypodiaceæ: G. **Perrin.**—Physiological study on the development of fruits and seeds: W. **Lubimenko.** Perforation of the pericarp causes an atmosphere with a lower percentage of carbon dioxide to surround the ovule, resulting in arrested development.—A disease of the oak: MM. **Griffon** and **Maublanc.** This disease, which since the spring has attacked the oaks in a great part of France, is due to a white mould of the genus Oidium. It spreads rapidly, and has caused great damage.—The minute structure of the sporozoites of *Plasmodium relictum*: Edmond **Sergent** and Etienne **Sergent.**

## CONTENTS.

THURSDAY, SEPTEMBER 10, 1908.

## NEW EDITION OF STRASBURGER'S BOTANY.

*A Text-book of Botany.* By Dr. E. Strasburger, Dr. Fritz Noll, Dr. H. Schenck, and Dr. G. Karsten. Third English edition, revised with eighth German edition by Dr. W. H. Lang. Pp. x+746. (London: Macmillan and Co., Ltd., 1908.) Price 18s. net.

THIS work is divided into two main divisions, "General Botany" and "Special Botany." The general botany commences with a section on morphology, external and internal. Some alterations from the second English edition have been made here, notably in the account and diagrams of mitosis. A paragraph on "reduction division," with illustrations, has been added. The description of the secondary tissues and their development is particularly good, but the new diagrams illustrating this subject do not add to the clearness.

Physiology is treated under the heads, stability of the plant body, nutrition, respiration, growth, movement, reproduction. There are numerous small changes and additions, chiefly due to research since the second English edition appeared. Several new illustrations, mostly taken from Schimper's "Plant Geography," have been introduced.

This is an excellent account of plant physiology for its size. A few criticisms, however, suggest themselves. Through an attempt to crowd too much into a small space, inadequacy, if not inaccuracy, has sometimes resulted. For example, in the discussion on the cause of the ascent of the transpiration current, the evidence for the theories based on "the cooperation of the living cells" and "the cohesive force of water" respectively is slurred over in a dozen lines, and twice as much space is devoted to dismissing "capillarity" and "atmospheric pressure," which, all admit, are quite insufficient as causes.

It seems a pity that the idea embodied in the term "circulation of nitrogen" has not been given prominence. Recent results tending to bridge over the gap between the taking in of $CO_2$ and the appearance of carbohydrates in assimilation are not mentioned.

The paragraph on hybridisation has been enriched by a short account of Mendelism. It has not been made sufficiently clear that the Mendelian proportions 2 : 1 : 1, &c., are only approximated to when large numbers are dealt with, and are dependent on the laws of chance. A slight inaccuracy in statement occurs in the last few lines of p. 314. It is not 50 per cent. *of the serrate leaved individuals*, but of the whole second generation, which are of hybrid nature. These 50 per cent. exhibit the dominant serrate character.

The greater part of the special botany has been re-written. The order of treatment is, as in the previous edition, from the lowest to the highest forms. Most of the sections on the Thallophytes have been enlarged and altered, and two extra classes have been added by the separation of the Heterocontæ from the green algæ and the division of the fungi into the classes Phycomycetes and Eumycetes. Numerous excellent new illustrations have been included which greatly add to the value of this part of the book. Particularly noticeable are several new figures of the behaviour of nuclei in the reproductive phenomena of the fungi. The Rhodophyceæ do not seem to have received enough attention compared with the other groups.

Amongst the Archegoniatæ the mosses are little altered. The classification of the ferns has been rearranged, and there are several new figures.

The remainder of the book, devoted to Phanerogams, has been completely re-written and re-illustrated. In the introduction to this part there is a very useful comparative table of the "Alternation of Generations." The treatment of the Gymnosperms, and especially of the Cycads, is distinctly good. In the Angiosperms, after a general description of each family, an account of some important genera of the family is given, the official plants of the British Pharmacopœia being noted in each case. This part of the book is very copiously and excellently illustrated, a large number of the figures being coloured. The colouring leaves something to be desired in several cases, but is much improved from the second English edition.

Throughout the work the arrangement and division into paragraphs is such as to secure the utmost degree of clearness. In each paragraph a leading idea is printed in larger type, so that it impresses itself on the memory, and serves as a centre round which the subsidiary ideas may be grouped. The usefulness of this is perhaps most noticeable in the part on physiology.

There are very few misprints. The only one worth noticing is on p. 280, line 41, where "heliotropism" should, of course, have been "geotropism."

The translator has been most successful in his work, the book reading as though originally written in English. In spite of the criticisms offered on a few points, this is one of the best, if not the best, text-book extant.

L. B. S.

## FOREST ENTOMOLOGY.

*Forest Entomology.* By A. T. Gillanders. Pp. 422+xxii; 348 figures. (Edinburgh and London: Wm. Blackwood and Sons, 1908.) Price 15s. net.

MR. GILLANDERS, who is woods manager to His Grace the Duke of Northumberland, has produced a useful book for beginners in his "Forest Entomology." "The main feature which is attempted," we are told in the preface, "is recognition of the insect from the damage, together with systematic characters and life-history details." The first-named ideal has been well carried out, the figures given from photographs of the damage done being a great help to the practical forester and novice of forest entomology; we much regret, however, to see that the insects which cause the damage are frequently not shown at all.

The introduction, of eighteen pages, deals briefly with classification, metamorphosis, and structure.

This part of the work we shall hope to see thoroughly revised in a future edition. The figure (10, p. 9) of typical mouth parts of insects is very poor, and the figure (2, p. 4) of the eggs of the lackey moth are certainly not typical of that insect, if they are the eggs of it at all. Several other figures in this section are also very unsatisfactory, such as Fig. 3, showing typical forms of larvæ; in this latter we see no caterpillar, no sawfly larva, and those that are shown are very unnatural. The first chapter deals with the Eriophyidæ or gall mites. The more common species that we find in woods and forests have their galls figured. In reference to the literature consulted and quoted, it is a pity the most important writings on the big-bud mite of Lewis and of Warburton are not mentioned.

There are two chapters on Coleoptera, the first dealing with chafers, long-horns, and weevils, including the troublesome pine weevils (*Hylobius abietis*) and the two Pissodes; we should like to have read a good deal more concerning these and the destructive beech Orchestes (*Orchestes fagi*).

The second chapter, of forty-five pages, deals entirely with bark beetles (Scolytidæ). The wood sculpturing of these destructive insects is shown by means of photographic reproductions. This part of the book is nearly complete, and alone makes it of value to the forester.

Pages 130 to 163 deal with oak galls formed by the Cynipidæ, and the chapter contains a useful synoptic table. Chapter v. deals with sawflies, including descriptions of the injurious pine sawflies (*Lophyrus pini* and *L. rufus*) and the large larch sawfly (*Nematus erichsoni*); the same chapter contains all that is essential for the forest student on the Siricidæ or wood wasps and the strange Megastigmi, parasitic on the seeds of the Douglas and silver firs.

Scale insects or Coccidæ form the subject of chapter vi.; the more important forest species are briefly described, including the ash scale (*Chionaspis salicis*) and the felted beech coccus (*Cryptococcus fagi*). Nothing is said about the great harm done by the former, or any suggestions as to how we may easily check its ravages. Regarding the felted beech coccus, the author writes:—

"A most interesting remedial measure has been brought under my notice at Blagdon, in Northumberland. With an inch auger bore three holes at about equal distances right into the centre of the trunk about three feet from the ground and sloping slightly towards the root of the tree. Into these holes [place] as much 'flowers of sulphur' as can be conveniently got in and then cork them firmly up with a plug of soft wood. This should be done in autumn and will be found successful."

We may point out that this has been tried frequently, and the coccus has not been affected in the least, except about four inches around the auger holes! A comparatively small number of Lepidoptera are described in chapter vii., but some of the more important ones are mentioned, such as the goat moth, vapourer, winter moth, oak tortrix, pine shoot tortrix, larch coleophora, and the new larch pest, *Argyresthia laevigatella*. The chapter on aphides, a family of insects at present little understood, contains an account of the pine chermes, six species being detailed and their general effects well illustrated. The recent valuable work of Börner[1] will, however, have to be included in a subsequent edition. Naturally, Diptera take up only a few pages, mostly on gall-flies or Cecidomyiidæ, which cause various deformities or galls on leaves, buds, wood, &c.

Several Psyllidæ are detailed in chapter x., including species on the ash, hawthorn, alder, and box.

There are also chapters on collecting and preparing insects, one on insecticides and general remedies, and also a list of trees with injurious insects.

The subject of beneficial insects is very cursorily dealt with, only four pages being devoted to this interesting part of economic entomology, but the author tells us that "the field of beneficial beetles in forest entomology is rather an unworked one," and probably the same may be said of the other groups, and hence, wisely, a few pages only are allotted to this subject, which is of more interest than any practical importance. There are two points we are very disappointed with in this work, and these are that the author, with all his wide, *practical* knowledge, has not told us, firstly, more of his own ideas, and, secondly, more of how we can prevent and destroy these interesting forest insects, which levy such a heavy toll amongst our forests, woods, and plantations.

Had this been done, the work, coming as it does from such an authority on forest insects and their ways, would have been of much greater value.

FRED. V. THEOBALD.

## OUR BOOK SHELF.

*An Introduction to the Theory of Groups of Finite Order.* By H. Hilton. Pp. xii+236. (Oxford: Clarendon Press, 1908.) Price 14s. net.

In many ways this book will prove a useful companion to treatises already available; especially, perhaps, on account of the large number of examples which it contains, and the hints for their solution. It may be confidently asserted that no example in group-theory is too elementary to be useful; the subject is on one side so very abstract, while on the other the individual properties of groups are numerous, and the protean disguises of the same group are amazingly varied.

The scope of Mr. Hilton's treatise may be indicated by stating that there is a chapter on Sylow's theorem, one on composition-series, and one on the characteristics of an Abelian group. All the main properties of Abelian groups appear to be mentioned; other groups that receive attention are those of the regular solids, and those known as Hamiltonian, linear homogeneous, and quaternion groups.

The chapter on characteristics is the last one, and does not profess to be more than a preliminary outline; it marks very well the limits of the author's plan, and will serve to induce the student to proceed to the very remarkable papers on this part of the subject by Frobenius, Burnside, and others. It is a pity that Mr. Hilton has not given a reference to these and some other of the most important memoirs; of course, no elaborate bibliography is expected in a work

[1] "Eine monographische Studie über die Chermiden." By Dr. Carl Börner. (Berlin, 1908.)

of this kind, but a select list would be useful to the beginner.

In writing on group-theory clearness is essential, and in this respect Mr. Hilton appears to be successful. Group-theory is so important that every advanced mathematical student ought to know something about its principles and methods. University teachers will now have a text-book which ought to help them in making the subject attractive and popular. A good many years ago Cayley foretold the development of group-theory, and his prophecy has been fully justified. The fact is that all analysis may be brought into connection with group-theory; and not only so, but in making this connection clear, we are submitting the particular subject (theory of numbers, algebraic functions, or what not) to its ultimate logical test, and disclosing its real and most fundamental basis.

It should be added that, with the help of Prof. Burnside, Mr. Hilton has given, by way of appendix, a list of twelve problems in group-theory which have not yet been solved. The best known of these is "Can a group of odd order be both non-cyclic and simple?" A definite answer to this question would give great satisfaction to students of group-theory, and as in the case of problems in higher arithmetic, a novice with a natural gift for these researches may succeed where the veterans have failed. G. B. M.

*A Short History of Philosophy.* By A. B. D. Alexander. Pp. xxii+601. (Glasgow: MacLehose and Sons, 1907.) Price 8s. 6*d.* net.

THE author offers this work as a substitute for G. H. Lewes's well-known "Biographical History of Philosophy," which, if for no other reason than that it was written expressly to discredit philosophy, has too long enjoyed its position as the one British attempt to exhibit the entire course of European speculation. Mr. Alexander does not emulate Lewes's literary brilliance, but he writes for a generation of readers who are willing to take the philosophic view even of philosophy, and to regard it not as a noxious counterfeit of knowledge, but as a necessary complement of positive thought at each epoch of man's history—an indispensable and highly significant part of the form and pressure of the time; such readers will welcome him as a competent and trustworthy guide to the salient features in the evolution of speculative thought.

The accounts which Mr. Alexander gives of the various systems of philosophy are clear and sound, and in all important cases have the vital quality that comes from first-hand acquaintance with the classics of his subject. He has dealt more fully with modern than with ancient philosophy, devoting nearly three-quarters of his book to post-Renaissance thinkers and more than half to writers since Hume. It is, perhaps, to be regretted that so much of the space rendered available by the author's restraint in the earlier stages of his enterprise has been given to German philosophers whose importance is national rather than European. It must be admitted, on the other hand, that the great names have received their due, and that, in particular, the chapters on Hegel will give renewed hope to many an honest student who has found the master himself only a shade more perplexing than some of his English interpreters.

The pages which we grudge to the lesser Teutonic lights might well have been used to make more adequate the author's picture of recent philosophical discussion in this country. The writer of a handbook for students must, of course, be reserved in his treatment of current controversies, but, in the case of a subject like the history of philosophy, he will give point to his whole work by a conclusion in which the questions of vital contemporary interest are at least indicated and set in their relations to the classical speculative movements. It is to be hoped that Mr. Alexander will find in a second edition of his useful work an opportunity of supplementing it in a manner which would render it still more acceptable to many others besides his scientific readers.

## LETTER TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### The Size of the Mammoth.

SEVERAL references have recently been made in NATURE to the size of the mammoth, and I venture to present some notes on the subject, the result of several years' observation and measurements, principally of North American species.

Three good species of true elephant occur in North America—the northern mammoth, *E. primigenius*; the southern, or Columbian, mammoth, *E. colombi*; and the Imperial mammoth, *E. imperator*. The first of these is the one commonly known as the mammoth, and is the species found in northern Siberia and Europe. This attains a height of about 9 feet or 9 feet 6 inches, though an occasional specimen may exceed this, just as now and then an Indian elephant exceeds the average size of the species. The Columbian mammoth reached a height of 11 feet, and the Imperial mammoth 13 feet to 13 feet 6 inches, being, so far as I know, the tallest species of elephant on record. Unfortunately, the Columbian and Imperial mammoths are mainly known from scattered teeth and odd bones, so that their exact proportions cannot be definitely given, even in the case of the Columbian mammoth, the most complete specimen of which lacks the lower limb bones. It may, furthermore, be said that it is occasionally difficult, if not impossible, to say whether a given tooth belongs to the Columbian or Imperial mammoth, but the typical or full-sized specimen may readily be distinguished.

The three species noted above occupied fairly definite ranges in North America, although there was a great overlapping of their boundaries, particularly between the two southern species. The southern boundary of the northern mammoth roughly follows that assigned to the great North American ice-sheet, and the Columbian slightly overlaps this on the east and west, and in the interior of the continent runs far northwards. The Imperial mammoth is not positively known to have reached the Mississippi River, but extended south into Mexico and west to the Pacific coast. This is a westward extension of the range assigned to the species in the report of the Maryland Geological Survey, and is based on material examined since that report was published.

Referring to the mammoth in the museum of the Chicago Academy of Science, it should be said that this specimen has been restored, all the long bones being lengthened, and that the specimen stands certainly 2 feet higher than it should. It has been painted over, so that it is very difficult to tell where the original bones leave off and the restoration commences. The animal is probably the Columbian mammoth, and it is said that the skull is that of a recent Indian elephant.

Finally, a word might be said in regard to the American mastodon, the size and proportions of which are definitely known. This species rarely reached a height of 9 feet 6 inches, the majority of specimens running about 9 feet; but it was a much more heavily built animal than the mammoth or the Indian elephant, so that a specimen 9 feet 6 inches high would weigh from one-third to one-half more than an Indian elephant of the same height—that is, it would weigh from eight to nine tons.

Brooklyn Institute Museum. F. A. LUCAS.

## SURVEYING FOR ARCHÆOLOGISTS.[1]

### II.

*Horizons—Earthly and Heavenly.*

So long as we are dealing with measurements of azimuth on the horizon, and altitude above the horizon, we are considering only our position on the earth—on that part of it which is bounded by our horizon. We are not dealing with the true position in the heavens of any body, whether sun or star, which may rise or set in the directions defined by our measures.

We are only dealing, in fact, with what is termed the *sphere of observation.*

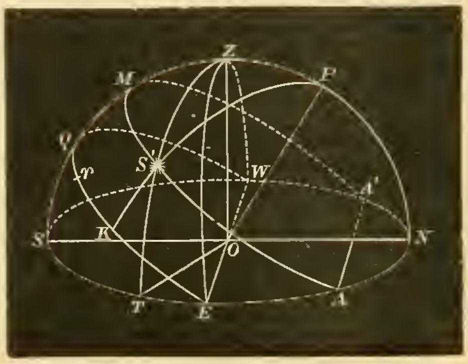


FIG. 4.—The sphere of observation. O, the position of an observer at the centre of the sphere, surrounded by the horizon; N. E. S. W. (the true cardinal points), with Z, the zenith, the point over the observer's head. The line N. S. is the true meridian line. The plane bounded by the line N. E. S. W. is the plane of the horizon, or the horizontal plane. The line O Z, a *vertical* line, is at right angles to the plane of the horizon.

The figure will illustrate what has already been said about azimuth, and will enable us to define some new technical terms which will be used later on. For *true* azimuths the zero is at N., which represents the N. point of the horizon, so that the azimuth of the E. point is 90°, of the S. point 180°, of the W. point 270°. Next let us take some intermediate points, A and T. The arc NA is the azimuth of A, the arc NT the azimuth of T. Sometimes it is convenient to define the position of a point on the horizon, not from the N. point (*azimuth*), but from the E. or W. point; we speak of this measure as *amplitude.* In any quadrant the one is the complement of the other, that is, added together, they make 90°.

The points A, T, like the points N. E. S. W., are represented as being on the horizon, so the distances of all these points from Z, called the *zenith distance,* are the same. If we represented these points not *on*, but *above* or *below* the horizontal plane, it is obvious that the zenith distances would not be the same. The higher the point is above the true horizon, as would happen if there were a hill there, the less the zenith distance.

The circle which we actually observe all round us when the heavens seem to rest on the surface which we see is termed the *visible horizon.* We imagine a plane parallel to the plane of the visible horizon, but passing through the centre of the earth; this is called the *rational* or *true* plane of the horizon.

So much for the horizon as a part of the earth's surface.

In the astronomical survey of ancient monuments, the determination of the azimuth of the various sight-lines, and the altitude of that part of the horizon which bounds them, is for the purpose of studying the sight-lines in relation to the rising or setting places of sun or star.

What we have to do, therefore, is to study the relation of the sphere of observation to what is called *the celestial sphere,* the sphere on which in old time the stars were supposed to be fixed by golden nails.

To do this we must pass from the consideration of the sphere of observation at any place to a study of the earth as a whole, and its movements, or at all events of some of them.

We have the earth in space with the universe of stars, almost infinitely removed, all round it, and we now know that the apparent movements of the stars from east to west, their daily risings, passing over the meridian and setting, in the sphere of observation at any place, are only the reflections of the earth's daily movement, or spin, on its axis from west to east.

The points at which this axis cuts the earth's surface are called the N. and S. poles, and half-way between these the earth is bounded by a circle called the *equator.* Now, as the daily motion of the earth is reflected in the apparent daily motion of the stars, so is the system of defining positions on the earth reflected in the system employed by astronomers in defining positions in the heavens.

As the earth is belted by *parallels of latitude* and *meridians of longitude,* so are the heavens belted to the astronomer with *parallels of declination* and *meridians of right ascension.* If we suppose the plane in which our equator lies extended to the stars, it will pass through all those which have no declination (0°). Above and below we have north and south declination, as on the earth's surface we have north and south latitude, until we reach the poles of the equator (90°). As on the earth we start from the *meridian of Greenwich* in the measure of *longitude,* so do we start from a certain point in the celestial equator occupied by the sun at the vernal equinox, called the *first point of Aries,* in the measure of what is termed *right ascension.*

So that we have terrestrial *latitude,* reckoned from the terrestrial equator, corresponding with celestial *declination,* reckoned from the celestial equator, and longitude corresponding with right ascension.

It is the *declination,* that is, the distance from the celestial equator, with which archæologists chiefly have to deal, for the reason that the rising and setting places of celestial bodies depend upon their declination; *bodies with the same declination rise and set in the same azimuths.*

Now the presentation of the plane of the horizon of a place to the surrounding stars which together constitute the celestial sphere varies vastly with its position on the earth's surface. Whether stars rise and set at all, or if they do whether they rise and set vertically or obliquely, depends upon this position, or, to be more precise, upon the latitude of the position. It is a pity that "calisthenics and the use of the globes" no longer form part of a liberal education, for a study of a terrestrial globe, which is a model of the earth in relation to the celestial sphere, gives us help in the matters we are now considering.

Such a globe is furnished with a wooden horizon, which represents the true or rational horizon passing through the centre of the earth as before defined. The axis of the globe prolonged is fixed into a brass ring representing the meridian, and the axis can be inclined at any angle in regard to the wooden horizon.

Now, wherever the archæologist is working, his

[1] Continued from p. 393.

observing place, bounded by his horizon, appears to lie at the top of the earth, and therefore parallel to

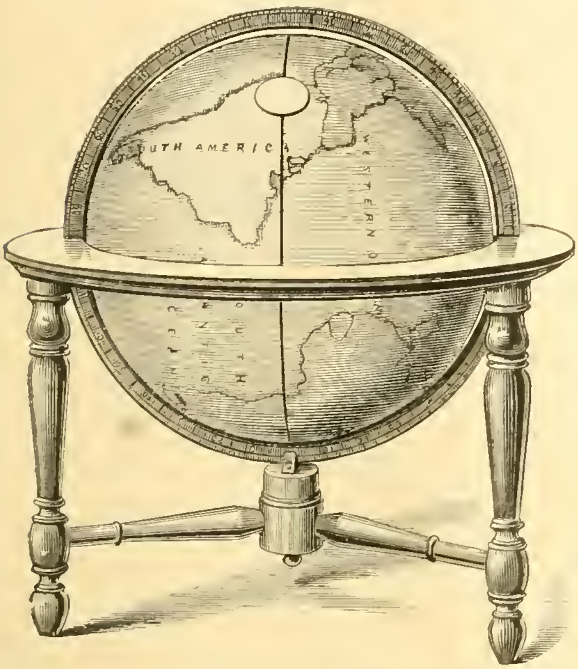

Fig. 5.—A model of the earth, showing that when the poles lie in the plane of the true horizon, and therefore of the wooden horizon which represents it, the horizon, represented by a wafer, of an observer situated on the equator, is carried vertically up and down by the earth's rotation; this motion reflected causes the apparent up-and-down motion of the stars as observed at the equator.

Fig. 6.—In this case the axis is inclined to the wooden horizon, which is parallel to the horizon of Britain when at the top of the globe. The wafer representing the horizon of Stonehenge is carried obliquely up and down in a direction parallel to the equator, so that the sun and stars rise obliquely to the horizon.

the wooden horizon; let us therefore use two wafers to represent local horizons, and place one on the equator and the second on Britain.

When we bring the equatorial wafer to the top of the globe, where it lies parallel to the wooden horizon, we find that on rotating the globe it sweeps down in a vertical plane. The wafer over Britain, parallel to the wooden horizon when it is brought to the top of the globe, when the globe is rotated takes an *inclined* path to the horizon. This happens because the axis, instead of lying in the plane of the wooden horizon, is inclined to it. This inclination of the axis varies with the latitude of the place, and so the angle of inclination of the path of the wafer to the wooden horizon varies with the latitude. If we so arrange our model earth that the inclination of the axis is the greatest possible and the earth's equatorial plane lies in the plane of the wooden horizon, it is obvious that the earth's movement will only cause a wafer at the pole to rotate; with this exception it will remain at rest, and as there is no vertical motion to reflect, the stars will neither rise nor set.

Now the value of these little experiments depends upon the already stated fact that the *apparent* movements of the heavenly bodies are brought about by the real movements of the earth, and the experiments show us that in regard to the horizon at any place the *true* movement of the underlying earth, and therefore the *apparent* movement of the overlying heavens, is vastly different.

At the equator an observer's horizon is being whirled round in a vertical plane at the rate of 1000 miles an hour; at the poles the horizon remains parallel to itself. In Britain we have a midway condition. Correspondingly with these differences, at the equator we have stars rising and setting vertically and rapidly; in Britain stars rising and setting obliquely and more slowly; at the poles the stars neither rise nor set.

We may now return for a moment to Fig. 4, which we have so far considered in relation to the sphere of observation. It really enables us to study as well the conditions of the celestial sphere for the horizon N. E. S. W. of, let us say, Stonehenge in lat. 51° N. P represents the position of the celestial pole, and EQW the inclination to the horizon of the celestial equator for that latitude. The lines EQ and ASM give the angle of slant as the sun or a star on the equator or in a northern declination rises above the horizon.

Two or three technical terms which will be often used afterwards may here again be referred to. PN gives the height of the celestial pole, which is the same as the latitude of the place, ZP its *zenith distance*; it will be seen that these are complementary to each other, that is, together they make up 90°. S representing a star or the sun, PS is its *polar distance*, as KS is its *declination* or distance from the equator; it is seen that these again are complementary to each other. The line SZ represents its zenith distance.

Norman Lockyer.

## *INTERNATIONAL CONGRESS ON TUBERCULOSIS AT WASHINGTON.*

THE International Congress on Tuberculosis to be held in Washington between September 21 and October 12 promises to be one of the most interesting and important in the history of these meetings. Presided over by the President of the United States, assisted by Dr. Edward L. Trudeau, acting as honorary president, Dr. John S. Fulton, secretary-general, Mr. Henry Phipps, of New York, as treasurer, an exceedingly strong national committee has been brought together, and very complete arrangements have been made for the exhibition of interesting plans and specimens, and for a full discussion of some of the more interesting questions and problems, medical and social, bearing upon the treatment and prevention of tuberculosis.

Great Britain, acting through an executive committee selected from a very large representative national general committee, and presided over by Sir William Church, with Dr. Theodore Acland as treasurer and Dr. J. J. Perkins as secretary, has for some time past been engaged in preparing a series of reports on the methods of combating the spread of tuberculosis and in carrying out treatment of this disease, which reports will be presented by national and other delegates.

When the executive committee was first formed the whole of the members met in London; but as soon as the general plan of work had been laid down it was decided that national committees in England, Scotland, and Ireland should meet in London, Edinburgh and Dublin, the Dublin committee being presided over by Her Excellency the Countess of Aberdeen. These committees have made the arrangements for the report from each country to be presented to the congress. They have also combined to send out an "exhibit" of plans, sections, pathological specimens, and other preparations for the large museum which has been arranged by the American Exhibition Committee working under Dr. Henry Beyer, of Washington. The keenest interest is being taken in the work of the congress, and President Roosevelt, in accepting the presidency, speaks of the modern crusade against tuberculosis as bringing "hope and bright prospects of recovery to hundreds and thousands of victims of the disease, who under old teachings were abandoned to despair. The work of this congress will bring the results of the latest studies and investigations before the profession at large, and place in the hands of our physicians all the newest and most approved methods of treating the disease—a knowledge which will add many years of valuable life to our people, and will thereby increase our public wealth and happiness. . . . Our country, which is honoured this year as the host of other nations in this great gathering of leaders and experts, and as the custodian of the magnificent exhibit which will be set up by the entire world, should manifest its appreciation by giving the congress a setting worthy of the cause, of our guests, and of ourselves. We should endeavour to make it the greatest and most fruitful congress which has yet been held, and I assure you of my interest and services to that end." Should this spirit pervade, as no doubt it does, the whole of the American executive, we may be assured of the fruitfulness of the congress.

From Great Britain Government delegates are being sent out in the interests of the various local government boards, and it is to be hoped, in view of proposed legislation on tuberculosis, that as full a report as possible of the work of the congress may be placed in the hands of those whose duty it will be to draw up legislation to be placed before the Parliament of the country. The universities, various medical schools and examining bodies, the Royal Commission on Tuberculosis, the Royal Society of Medicine, municipalities, the Victoria Jubilee Institute for Nurses, King Edward VII. Sanatorium, the National Association for the Prevention of Consumption, Invalid Children's Association, and other institutions are sending out representatives to assist in the discussion of such questions as the portals of entry, sources and channels of infection, especially the path of the tubercle bacillus from the exterior to the lungs, vital importance of early diagnosis, comparative importance of treatment in sanatoria near at hand, of entire change of climate, the present status of sanatoria treatment, diet in pulmonary tuberculosis, graduated labour in the treatment of tuberculosis, urgent necessity for hospitals for far advanced cases, relative frequency by bovine infection of lung disease compared with that of other organs, the economical aspect of tuberculosis, adverse industrial conditions, the social control of tuberculosis, after care of arrested cases, educational methods and agencies, promotion of immunity, responsibility of society for tuberculosis, &c.

One of the most interesting sections is that dealing with State and municipal control of tuberculosis, in which the provisional programme includes laws and ordinances relating to tuberculosis, especially with reference to notification, Government care of tuberculous patients, educational propaganda and scientific research under Government auspices, sanitary measures in the home, including disinfection, better housing, ventilation, &c., sanitary surveillance over travellers and those engaged in trades and occupations, in public buildings, factories and workshops, &c., prevention of tuberculosis among children and adolescents, including the subjects of heredity, environment, schools, factories, playgrounds, &c. In the section dealing with tuberculosis in animals and its relation to man, the prevalence of the disease amongst domestic animals, the modes of infection and the methods of diagnosis are all to be dealt with in a series of interesting papers, as are also resistance to tuberculosis in different genera, species, breeds, families and individuals, the methods for controlling the disease in animals, the comparative bacteriology and pathology of tuberculosis in animals, the relation of tuberculosis in animals to the pubilc health, including the evidence for and against the transmission of tuberculosis from animals to man, milk hygiene and meat hygiene in relation to tuberculosis in animals. These papers should lead to most enlightening discussions, and we may confidently look forward to some very interesting and important reports.

## THE LATE M. MASCART.

THE ranks of French physicists have suffered sad losses of late. Last week it was Henri Becquerel whose obituary we published. To-day it is that of M. Mascart, whose death occurred on August 26 at his country residence at Poissy, where he had lain suffering for some months.

Éleuthère Élie Nicolas Mascart was born at Quarouble, near Valenciennes, on February 20, 1837. He was a scholar of the Ecole normale supérieure, taking his first degree in science in 1858, was admitted *agrégé* in 1861, and *docteur-ès-sciences* in 1864. His first post was that of conservator of the collections in the École normale. Then he became professor of physics in the Lycée de Versailles, and subsequently at the Collège Chaptal. He also acted as deputy for Regnault at the Collège de France during the later years of that great master; and in 1872 succeeded to the occupancy of his chair. Devoted to experimental physics, and, like his master, possessed of a great capacity for the methodical and patient treatment of details, he early made his mark in the scientific study of meteorology. It was therefore an appropriate appointment when in May, 1878, he was elected to the post of director of the Central Bureau of Meteorology in Paris. This post he filled for nearly thirty years, retiring only in 1907. He succeeded in the face of numerous difficulties in gradually perfecting the equipment and organisation of his bureau, and in establishing the systematic publication in France of weather-charts and weather-forecasts.

Mascart's earliest researches were chiefly devoted to optics; later electricity, magnetism, and the determination of the electrical units claimed his attention. The pages of the *Comptes rendus*, of the *Annales scientifiques de l'École normale*, and of the *Journal de Physique* attest his industry and his scientific insight. It must suffice here to indicate a few of his principal investigations. He was one of the first to apply photography to the study of spectrum analysis, and in 1862 constructed a spectrograph with a quartz train with which he photographed the ultra-violet spectra of many of the metals, adding many new lines to those already known, and directing attention to the harmonic relations presented by groups of lines, for example, by those of magnesium. He then made a number of standard determinations of wave-lengths by use of Nobert's gratings. Fizeau reported to the Academy of Sciences that this was the most thorough and satisfying piece of work on wave-lengths that had been made since the researches of Fraunhofer, and on his recommendation Mascart was awarded the Prix Bordin. He also prepared tables of the dispersion of the principal kinds of glass used by opticians, and of iceland spar. He devised, with M. Perrin, a novel optometer, and studied the distribution of the colour-sensation over the retina of the eye. In the theory of light he presented, in 1871, an elaborate memoir on the calculation of the interference fringes formed in different circumstances, carrying out the investigation with great generality, and giving the results of comparison between theory and experiment. He investigated the phase-relations in the light reflected from metallic films of great tenuity; and he wrote a series of didactic articles in the *Journal de Physique*, then (1872) newly-founded, on the application of the spectroscope to the observation of interference phenomena. He also produced an improved apparatus for the study of interference, based on the phenomenon of Talbot's fringes. For the study of colour-mixtures he devised an instrument producing three parallel spectra, each of variable intensity, which could be superposed on one another, and displaced so as to yield a mixture of any three spectrum tints in any proportion. An important paper in 1874, followed by another in 1878, was devoted to refraction and dispersion in gases, some twenty being examined. Another research dealt with the index of refraction of water under pressure. Doppler's theory also was examined, and an investigation was made, of great interest in the light of recent ether theories, whether the proper motion of the earth had any appreciable effect on the phenomena of optics. The conclusion was that optical phenomena give no indication of the absolute motion of a body, but only of its relative motion. This memoir was awarded the Grand Prix des Sciences mathématiques in 1874 on the report of M. Fizeau.

In 1876, M. Mascart published a treatise on statical electricity greatly in advance of any previously existing on the Continent in that it introduced to Continental readers the potential theory developed on the basis of Green's book, and the electrometric work of Lord Kelvin. The volume included several matters of original interest, comprising a research on discharges across long distances, and on the measurement of great differences of potential. About this time also he made new observations on atmospheric electricity, on the influence of ozone (*i.e.* air ionised by the passage of sparks) on the formation of fogs, and on the influence of electricity on evaporation. In 1877 he published in the *Journal de Physique* an elegant exposition of the elementary theory of magneto-electric and electrodynamic machines, based on the energy formulæ of Helmholtz and Thomson. In this article the law of efficiency of motors, at that date generally misunderstood, was correctly stated. In the succeeding year, in collaboration with M. Angot, he made many tests on Gramme machines and others, to test his formulæ. The influence of Lord Kelvin's volume of reprinted papers on electrostatics and magnetism now became very great on Mascart's work. He communicated to the Académie des Sciences a paper on the reciprocal action of two electrified spheres, employing Thomson's method of electric images; another paper on the propagation of electric impulses along conductors; and another on the theory of induction.

Public work began to fall upon M. Mascart, in connection with the electrical machinery shown in the Paris Exhibition of 1878; and, still more, in connection with the Electrical Exhibition and the International Electric Congress of 1881. In the congress he took an active part, particularly in the debates on the then burning question of the electric units. He contributed to the settling of these matters by a fine determination of the absolute electrochemical equivalent of silver, which he deposited from a nitrate solution, measuring the current in absolute terms by means of a current-weigher, a balance of his own design. The value found was about one-half of one per cent. below those respectively found by Lord Rayleigh and Prof. Kohlrausch. Between 1881 and 1884 he completed a re-determination of the unit of resistance, by the methods of Weber and Kirchhoff, finding as a result 106·3 centimetres for the length of the mercury column to represent the ohm, Lord Rayleigh's figures being 106·28 and 106·24. In these years also, he had, in conjunction with his friend M. Joubert, prepared a text-book of electricity and magnetism, based on his courses at the Collège de France. It introduced many points from the treatise of Maxwell, and the use of the C.G.S. system of units.

In 1884 he was elected to the Académie des Sciences in the place of Jamin. Of that distinguished body he became an active member, being at various times vice-president, perpetual secretary, and in 1904 president.

Being a man of affairs he was frequently in request to advise the Government on matters within his competence. He was vice-president of the consultative committee on arts and manufactures, and president of the commission on inventions for the War Ministry. He was also a member of the Bureau of Longitudes, and of the International Bureau of Weights and Measures. In recognition of his public services he was created Grand Officer of the Legion of Honour. He took a prominent part in organising the electrical sections of the exhibitions of 1889 and 1900, and in the latter year was president of the electrical congress which met in the exhibition. He was widely travelled, and had been an active member of the Chicago congress in 1893, which he followed up by a visit to the Yellowstone Park. He was profoundly interested in the establishment of the meteorological station at the top of the Eiffel Tower, and it was a particular pleasure with him, during the exhibition of 1900, to conduct parties of scientific friends to the special gallery above the highest to which the public had access, to show them the observing instruments therein installed.

Amidst these busy avocations he still found time to write. His "Traité d'Optique," in four volumes, which appeared between 1890 and 1893, possesses all the elegance of style peculiar to writers trained in the school of Laplace and Arago and Verdet. It is particularly rich in the sections of interferences and meteorological optics. In 1900 he published a "Traité de Magnétisme terrestre" in one volume.

Mascart was president of the Société française de Physique, and at another time of the Société internationale des Électriciens. He was elected in 1885 an honorary member of the Physical Society of London; in 1892, Foreign Member of the Royal Society; in 1900 vice-president, and in 1901 honorary member of the Institution of Electrical Engineers.

After his retirement last year, at the age of seventy, from the directorate of the Bureau of Meteorology, his health, which had suffered under his strenuous activities, broke down, and even the repose of his country residence failed to bring recovery. He was buried with military honours on Saturday, August 29, in the cemetery of Montparnasse.

## THE LATE EARL OF ROSSE.

THE Earl of Rosse, whose death on August 29 has been already announced, inherited a name of great renown in science. It was during his childhood that his father, the third Earl, erected the mighty reflecting telescopes at his seat at Birr Castle by which the name of Lord Rosse became famous throughout the world. The third Earl was endowed by Nature with much mechanical skill, and as a means of utilising his tastes and opportunities in the best possible manner for the advancement of knowledge he commenced to make reflecting telescopes. Every detail of the work was carried out in the workshops which gradually grew about Birr Castle. Incessant experiments were made to improve the methods of casting, grinding, and polishing the specula, until at last his efforts culminated in the mighty six-foot reflector which even at this day, notwithstanding the advances of the last sixty years, has still the greatest aperture of any astronomical instrument in the world.

The great six-foot telescope at Birr, or Parsonstown, as the little country town used then to be called, soon gave abundant proof of its power. The most notable achievement was the discovery of the spiral nebulæ, which were not visible by any other telescope at that time existing. Indeed, the spiral nebulæ were not altogether credited in some quarters, until the advent of photography in recent years put an end to all doubts and showed that the spiral nebulæ abound in such myriads as to form, next to the fixed stars themselves, the most characteristic objects in the sidereal spaces.

It was under the shadow of the great telescope and amid such inspiring surroundings that Lord Rosse was reared. The sons of the third Earl inherited the mechanical tastes of their father, and joined eagerly in the practical work of the laboratories and workshops at Birr Castle. The eldest, Lord Oxmantown, succeeded to his father's scientific gifts no less than to his title and estates, and the youngest, the Hon. C. A. Parsons, following the natural development of his tastes from childhood, has achieved fame for his country as well as for himself by the splendid invention of the steam turbine.

The education which Lord Rosse derived from his father's precept and example was, of course, supplemented by the necessary education of a more conventional type. In this he was also exceptionally fortunate. The two first mathematical men of their year (1855) in Trinity College, Dublin, were John Purser, the late distinguished professor of mathematics in Belfast, and the Rev. T. T. Gray, who is at present a most respected senior fellow of his college. First one of these men (Gray) became resident at Birr, and to him the education of Lord Oxmantown was entrusted. He was succeeded by Purser, and under such admirable tuition the future Earl of Rosse developed much power in mathematics and its physical applications. In due course he entered Trinity College, Dublin, and had there a distinguished career.

The third Earl had been president of the Royal Society for several years, and his personal scientific distinction, as well as his unrivalled position as one of the most bountiful and most capable patrons of science, naturally placed him in intimate association with the leading men of science of the day. Sir John Herschel, Romney Robinson, Sabine, Fairbairn, Lyell, South, and many other distinguished persons in the middle of the last century were the friends of Lord Rosse. As Lord Oxmantown always resided with his father either in the ancestral home at Birr Castle or when a visit was paid to London, or a cruise was taken in their yacht, his years of early manhood were passed in close association with the illustrious friends of his father, and he had thus unique advantages of making acquaintance with science and with scientific workers. On one occasion (more than forty years ago) we know of Lord Oxmantown's spending a long day with Babbage, who was enthusiastically explaining to him the details of that wonderful analytical engine which would perform every description of calculation up to fifty significant figures that the mind of man could render into formulæ. Babbage had many parts of the engine to exhibit. But though the differential engine was to some extent completed, the much more formidable analytical engine had not made much progress beyond the drawings, in which, however, it was believed that the characteristic mechanical difficulties had been overcome. Another time, Lord Oxmantown and his brothers would be the guests of Wheatstone for an afternoon, who would explain to them his inventions of the moment, such as the original printing telegraph or the inverted stereoscope, that presented objects hollowed out instead of in relief. Even in those early days of electricity Gassiot, at his home in Clapham, showed to the great Earl, as well as to Lord Oxmantown and his brothers, his wonderful battery of many thousand cells by which effects which at that time seemed marvellous were produced.

A specially notable incident in the early career of Lord Rosse as an astronomer was a visit which he paid in 1866 to the observatory of Sir W. Huggins at Tulse Hill. It was a memorable time in modern astronomy. Huggins had commenced that great series of spectroscopic discoveries which, by the labours of himself and others, have so amazingly extended our knowledge of the heavens. On the night in question Huggins was observing the new star T Coronæ, which, after a few days of brightness, had then declined to the sixth magnitude. We are now so much accustomed to the outbreak of new stars and to the occurrence of bright lines in the spectra of such stars that it requires a special effort to recall the interest with which these discoveries were received at the time of their making. Huggins showed these lines to Lord Rosse, who also saw another most interesting object on that same evening. It was the linear spectrum of the first planetary nebula of which the gaseous nature had recently been announced.

With such opportunities and with the splendid instruments available at Birr, Lord Rosse devoted himself keenly to practical astronomical work. His first achievement was his magnificent drawing of the great nebula in Orion. It is probably the most elaborate piece of astronomical portraiture ever completed. It occupied about seven years of practically continuous work at all available opportunities with the six-foot reflector. The beautiful engraving which was made from Lord Rosse's drawing of the nebula is a familiar object on the walls of astronomical observatories. Among his other astronomical investigations we may mention those of the lunar radiation of heat. On this he was engaged up to the time of his last illness, and, indeed, at the recent meeting of the British Association in Dublin Sir Howard Grubb exhibited a short-focus mirror of remarkable construction which he had recently made at Lord Rosse's request to provide further instrumental power for his lunar work.

Lord Rosse had been Chancellor of the University of Dublin since 1885, and he served as president of the Royal Dublin Society (1887–1892) and president of the Royal Irish Academy (1895–1900). He was also one of the visitors of Greenwich Observatory.

Lord Rosse married in 1870 the Hon. Frances Cassandra Hawke, only child of the fourth Lord Hawke. He is succeeded by his eldest son, Lord Oxmantown, who was born in 1873. His second son is the Hon. Geoffrey Laurence Parsons, and his daughter, Lady Muriel Parsons, was married in 1906 to Colonel H. M. Grenfell, C.B.

## THE DUBLIN MEETING OF THE BRITISH ASSOCIATION.

ONE of the largest and most successful among recent meetings of the British Association has just been concluded in Dublin. The following return shows the number of tickets issued in the various classes of members:—

| | |
|---|---|
| Old life members ... ... ... ... | 288 |
| New life members... ... ... ... | 24 |
| Old annual members ... ... ... | 456 |
| New annual members ... ... ... | 111 |
| Associates ... ... ... ... ... | 1,152 |
| Ladies ... ... ... ... ... | 222 |
| Foreign members ... .. ... | 14 |
| Total ... ... ... | 2,270 |

The various sections began work on Thursday, September 3. Most of them were located within the ample walls of Trinity College, and outlying centres were easily reached by means of the free motor service organised by an indulgent local committee. That service, creditable as it was, was greatly surpassed in value by the indicator boards announcing what papers were "up" in the various sections. These boards were mounted in places visible to everybody present. The letters A to L were written in large type in a horizontal row, and underneath each letter was hung a card bearing a number indicating the paper just being read in the section denoted by the letter. The service was maintained by four special operators per section, and it enabled members to bide their time comfortably in any section until their favourite paper took its turn in another. This useful innovation must be put to the credit of Prof. W. H. Thompson, one of the local hon. secretaries.

Thursday's sections began in a downpour of rain which contrasted unfavourably with the sunshine of the day before. The intersectional motor service was little in request, as nobody cared to leave the sheltering roof once it was reached. The various sectional meetings were, however, well attended, notably those of geology, educational science, and agriculture, the average attendance being about 150 per section.

About fifty members visited Guinness's Brewery at St. James's Gate at noon, and were shown over the vast works by the principal members of the scientific staff.

The Provost's garden party in the afternoon was largely attended in spite of the prevailing drizzle, though many members were absent. The Provost of Trinity College, Dr. Anthony Traill, braved the wintry blast manfully, and stood at the gate of the Fellows' Garden to receive his unexpectedly numerous guests. The latter kept to the marquees and the gravel walks, and enjoyed themselves prodigiously.

The conversazione given in the evening by the Royal Dublin Society at Leinster House proved one of the largest receptions on record. The 3000 members of the Royal Dublin Society were, of course, all invited, and as practically all the members of the British Association present in Dublin attended, the number of guests was more than 4000. The queue of carriages extended along several streets, and took two hours to discharge the occupants. On arrival the guests were received by Lord Ardilaun (president of the Society), the Right Hon. Frederick Trench, and Sir Howard Grubb. There were numerous scientific exhibits by local men.

In the lecture theatre Mr. W. H. Vipond Barry gave an organ recital, while subsequently lantern demonstrations were given by Rev. W. S. Greene and Dr. E. MacDowel Cosgrave, the subjects being "Scenes and Incidents in the West of Ireland" and "Old Dublin" respectively.

The Lord Lieutenant, accompanied by several members of his staff, arrived at 9.30, and spent some time inspecting the exhibits.

The sections started in full force on Friday, the weather having cleared up completely. The encounter between Sir William Ramsay and Prof. Rutherford in Section A drew a large attendance of distinguished physicists, but the keenest local interest was evoked by Mr. T. W. Russell's appearance at the section for Economic Science and Statistics, and the discussion on land purchase and the nationalisation of railways in which he took part.

A special meeting of the Senate of Dublin University was held at 2 p.m. for the purpose of conferring honorary degrees. The University Caput consisted of Mr. Justice Madden, Vice-Chancellor, Dr. Anthony Traill, Provost, and Mr. Frederick Purser, Senior Master. As each candidate was summoned to the dais, the Public Orator, Dr. L. C. Purser, proclaimed his titles and qualifications in Latin. The names of those who received degrees are to be found on p. 471 of the present issue under the head of University and Educational Intelligence.

*Meeting of the General Committee.*

At a quarter-past three o'clock a meeting of the general committee was held at Trinity College, Mr. Francis Darwin occupying the chair, when it was decided to hold the meeting of 1910 at Sheffield, and that of 1911 at Portsmouth.

On the motion of Sir Arthur Rücker, Prof. J. J. Thomson, F.R.S., was elected President for the Winnipeg meeting in 1909, the date of which was fixed for August 25 to September 1.

The afternoon engagements of Friday were divided between the general committee, a garden party at Dunsink Observatory, another at Saint Patrick's Cathedral, a visit to Messrs. Jacob and Co.'s biscuit and cake factory, and a special *matinée* of Irish plays at the Abbey Theatre, where Mr. W. B. Yeats gave an address on the recent development of native Irish drama.

The drive to Dunsink in special brakes was enjoyed by 200 members, who accepted the invitation of the Astronomer Royal and Mrs. Whittaker. The Observatory is situated to the north of Phœnix Park, and is best known to the Dublin public as the centre from which "Irish time" is furnished to the public timepieces of Ireland. The transit circle was, naturally, inspected with special interest.

Dean Bernard's garden party at St. Patrick's was also well attended, and was distinguished by the presence of the Lord Lieutenant of Ireland.

The Lord Mayor of Dublin took sixty members of the Association in his "flagship," the *Shamrock* (he is admiral of the Port of Dublin), down the Liffey to see the main drainage and electric light works at the Pigeon House, and gave a luncheon on board after the works had been inspected.

In the evening, Prof. H. H. Turner, F.R.S., gave an address on Halley's Comet at the Royal University before a crowded audience.

Saturday was devoted to excursions, in which 1100 persons took part. The objectives chosen were (1) the Boyne valley; (2) Bray, Powerscourt, and Kilruddery; (3) Glendalough; (4) the Rock of Cashel; (5) the Shannon and Clonmacnoise.

In the evening, the Classical Association of Ireland gave a reception in the Royal College of Physicians, and Dr. A. E. Tutton, F.R.S., gave the annual lecture to the operative classes before a large audience in the Royal University, choosing for his subject "The Crystallisation of Water."

Sunday was observed by special services in the Episcopalian, Presbyterian, and Roman Catholic chuches, the attitude of the respective churches towards science being expounded by the various preachers.

The afternoons of Monday, Tuesday, and Wednesday were set apart for garden parties at St. Anne's, Clontarf (Lord Ardilaun's home), the Zoological Gardens, and the Viceregal Lodge respectively.

On Monday, September 7, Prof. W. M. Davis, of Harvard University, gave a largely-attended lecture on "The Lessons of the Colorado Cañon."

The final meeting of the Association took place on Wednesday, September 9, at 3 p.m., at the Royal University.

E. E. Fournier.

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Subjoined is a synopsis of grants of money appropriated for scientific purposes by the general committee at the Dublin meeting.

| | £ |
|---|---|
| *Section A.—Mathematical and Physical Science.* | |
| Turner, Prof. H. H.—Seismological Observations | 60 |
| Shaw, Dr. W. N.—Kites Committee | 10 |
| Preece, Sir W. H.—Magnetic Observations at Falmouth | 50 |
| Gill, Sir David—Establishing a Solar Observatory in Australia | 50 |
| *Section B.—Chemistry.* | |
| Roscoe, Sir H. E.—Wave-length Tables of Spectra | 10 |
| Divers, Prof. E.—Study of Hydro-aromatic Substances | 15 |
| Armstrong, Prof. H. E.—Dynamic Isomerism | 35 |
| Kipping, Prof. F. S.—Transformation of Aromatic Nitramines | 10 |
| Kipping, Prof. F. S.—Electro-analysis | 30 |
| *Section C.—Geology.* | |
| Lamplugh, G. W.—Fossiliferous Drift Deposits | 11 |
| Herdman, Prof. W. A.—Fauna and Flora of British Trias | 8 |
| Harker, Dr. A.—Crystalline Rocks of Anglesey | 1 |
| Gregory, Prof. J. W.—Faunal Succession in the Carboniferous Limestone in British Isles | 10 |
| Kendall, Prof. P. F.—Erratic Blocks | 12 |
| Lapworth, Prof. C.—Palæozoic Rocks | 15 |
| Watts, Prof. W. W.—Composition of Charnwood Rocks | 2 |
| Watts, Prof. W. W.—Igneous and Associated Sedimentary Rocks of Glensaul | 20 |
| Joly, Prof. J.—Investigations at Briskra | 50 |
| *Section D.—Zoology.* | |
| Woodward, Dr. H.—Index Animalium | 75 |
| Hickson, Prof. S. J.—Table at the Zoological Station at Naples | 75 |
| Herdman, Prof. W. A.—Hereditary Experiments | 10 |
| Shipley, A. E.—Feeding Habits of British Birds | 5 |
| *Section E.—Geography.* | |
| Murray, Sir John—Rainfall and Lake and River Discharge | 10 |
| Murray, Sir John—Investigations in the Indian Ocean | 35 |
| *Section F.—Economic Science and Statistics.* | |
| Palgrave, R. H. Inglis—Gold Coinage in Circulation in the United Kingdom | 6 |
| Cannan, Prof. E.—Amount and Distribution of Income | 15 |
| *Section G.—Engineering.* | |
| Preece, Sir W. H.—Gaseous Explosions | 75 |
| *Section H.—Anthropology.* | |
| Munro, Dr. R.—Glastonbury Lake Village | 5 |
| Myres, Prof. J. L.—Excavations on Roman Sites in Britain | 5 |
| Read, C. H.—Age of Stone Circles | 30 |
| Read, C. H.—Anthropological Notes and Queries | 40 |
| Hogarth, D. G.—Researches in Crete | 70 |
| *Section I.—Physiology.* | |
| Schäfer, Prof. E. A.—The Ductless Glands | 35 |
| Sherrington, Prof. C. S.—Body Metabolism in Cancer | 20 |
| Waller, Dr. A. D.—Electrical Phenomena and Metabolism of *Arum spadices* | 10 |
| Hickson, Prof. S. J.—Table at the Zoological Station at Naples | 25 |
| Waller, Dr. A. D.—Reflex Muscular Rhythm | 10 |
| Waller, Prof. A. D.—Anæsthetics | 25 |
| Starling, Prof. E. H.—Tissue Metabolism | 20 |
| Sherrington, Prof. C. S.—Mental and Muscular Fatigue | 40 |
| *Section K.—Botany.* | |
| Scott, Dr. D. H.—Structure of Fossil Plants | 5 |
| Oliver, Prof. F. W.—Botanical Photographs | 10 |
| Darwin, Dr. F.—Experimental Study of Heredity | 30 |
| Blackman, Dr. F. F.—Symbiosis between Turbellarian Worms and Algæ | 10 |
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## SECTION B.

### CHEMISTRY.

Opening Address by Prof. F. S. Kipping, D.Sc., Ph.D., F.R.S., President of the Section.

On taking the Chair of this Section my first duty is to express my personal thanks to the Council of the British Association for having chosen me to fill this position of honour.

At this meeting the Association is enjoying, not for the first, but for the fourth time, the generous and genial hospitality of the citizens of Dublin; it is my privilege, on behalf of all the members of this Section, to tender our cordial thanks to our hosts for giving us this opportunity of meeting again in the capital of Ireland.

During the past few months we have read in the daily journals—and we sincerely hope it may be true—that there are signs of the commencement of a great development of the resources of this island; as such a desirable event must be closely connected with, and, indeed, may even be dependent on, the vitality of the chemical industries of the country, the moment seems opportune for the consideration of a subject which has a direct bearing on both commerce and chemistry.

Although this Section is chiefly occupied with matters relating to pure science, the discussion of industrial questions is also regarded as one of its important functions; it does not attempt to distinguish pure from applied chemistry, and any problem which concerns either is deemed worthy of its attention.

From this point of view I propose to consider whether any steps can be taken to place the chemical industries of the United Kingdom of Great Britain and Ireland in a more prominent position than that which they now occupy in the world of commerce.

The subject is not new; it has been dealt with by many, but principally by those more directly interested—prominent members of the Society of Chemical Industry, who are far better qualified to express opinions on commercial matters than am I. It is perhaps presumption on my part to attempt to add anything to what has been said by such leaders of industrial chemistry, but I propose to deal with the subject from a very different standpoint—namely, from that of the teacher in the class-room and laboratory. Even if I fail to make a single suggestion of immediate practical value, the question is one of such magnitude and so many-sided that I feel justified in bringing it under the notice of this Section. It is not merely a matter of money, of a few millions or of a few tens of millions sterling. There are few branches of industry to which chemistry, in one way or another, is not of supreme importance. Whether we look to the great shipbuilding interests, dependent on the progress of metallurgy; to our cotton and linen trades, where cellulose reigns supreme; to our dye-houses or to our breweries, or to any other industry, great or small, there do we find problems in chemistry awaiting solution, and the nation which solves them will not only progress in civilisation and contentment, but will also justly claim to have taken a leading part in the advancement of science.

It is not then in any grudging spirit of envy that we approach this question; recognising the splendid work of men of other countries, rejoicing in the services which they have rendered to the world at large, our only desire is not to lag behind in the general intellectual and industrial advance of nations.

It is unnecessary to trouble you with any detailed comparison of the position which we occupy to-day with that which we have taken in the past. The fiftieth anniversary of the epoch-making discovery of mauve was held only two years ago, and the proceedings are still fresh in our recollection; the pæans of congratulation addressed to the discoverer (now, alas! no longer with us) were marred by a plaintive note, a note of lamentation over our lost industry, the manufacture of dyes. The jubilee of the founder of the colour industry in this country was also the occasion for pronouncing its funeral oration. If this were the full extent of our loss we might bear it with equanimity; but it is not so much what has already gone as what is going and what may go that are matters of such deep concern. Those who doubt the seriousness of our condition may find statistical evidence, more than sufficient to convince them, in the technical journals and in the Board of Trade reports of recent years.

The facts there disclosed show that in the manufacture of "fine chemicals," including perfumes, alkaloids, and crude coal-tar products, as well as dyes, the decadence of our industry is far advanced; in the case of heavy chemicals our position, perhaps, is not quite so serious at the present moment, but the future is dark and threatening. Chemical industries are so intimately connected and dependent on one another that the fate of one may determine the fate of all; the by-product of one process is often the raw material of another. Who, then, can deny that the patience, perseverance, and high scientific skill, which have built up the colour industry abroad, if applied, as they have been and are being applied, to the manufacture of heavy chemicals, will not soon defy all competition from less progressive countries?

Such a possibility is full of national danger. It has been pointed out—and the prophecy cannot be regarded as unduly pessimistic—that from present indications a time will arrive when we shall be dependent on outside sources, not only for our food-supply, but also for our means of self-defence. When nitrates are exhausted, when nitric acid and ammonia are prepared from the components of the atmosphere, when all chemical industries have been so highly developed abroad that they have completely vanished from these Islands, and when their loss has reacted on all our other important industries, then, indeed, shall we feel the pinch of poverty; then, indeed, must we submit to national decay.

Is it possible to remedy the present unsatisfactory state of affairs, and to guard against an ominous future?

During the Perkin Jubilee celebrations Prof. Carl Duisberg answered this question, in so far as it concerns the coal-tar colour industry, by an uncompromising negative. In an able and interesting speech he pointed out that, although the Briton is in general a practical man, he is lacking in patience, in the power of waiting for success; he expects to be compensated in hard cash, and at once, for his work or for his capital outlay. The German, on the other hand, is primarily a theorist possessing endless patience, and works without any immediate prospect of pecuniary reward; he has now learnt to be practical as well, but not at the expense of his ideals. It is to this happy combination of qualities that Prof. Duisberg ascribes the success of his countrymen in the coal-tar colour industry—a success which he considers we are powerless to emulate, with which it would be futile for us to try and compete.

With this view that our chemical industries must submit to gradual extinction, even when it is held by so high an authority, we cannot and must not agree; if one nation can learn to be practical, we—the four nations of these islands—one or all, can learn to be plodding and patient, and to appreciate the importance of theory. We may be encouraged in our efforts to do so by the opinions of others, countrymen of Prof. Duisberg, eminent in pure or applied science. Prof. Ostwald, discussing this subject, said that he was sure the difficulties were considerable only in the beginning,[1] while Prof. Lunge, in an address to the Royal Institution,[2] made use of the following words: "Seeing that in pure science the people of Great Britain have never lagged behind any other nation, and that, on the contrary, the land of Newton and Faraday has been a beacon to all others at more than one epoch, there is absolutely no valid reason why she should now, or at any other time, be behind any other in the combination of science with practice."

Here, indeed, is encouragement, and from one who has had ample opportunity for studying the conditions which obtain in this country. Surely, therefore, we ought to have some confidence in ourselves and try our best to regain a strong and healthy position rather than fold our hands in a spirit of hopeless resignation.

The new Patent Act which came into force this year, and for which the country is so much indebted to the strenuous advocacy of Mr. Levinstein and Sir Joseph Lawrence, seems to many to have inaugurated a new era, and to have removed one of the principal causes of the decline of our chemical industries; if this be so, it is all the more important that the representatives of chemical science should be ready and willing to join hands with the manufacturers in order to assist in the process of regeneration.

The principal changes which have been introduced by the new law are, of course, familiar to all. The most important one, which came into operation on August 28 last, is that which requires that the article or process which is protected by the patent must be manufactured or carried on to an adequate extent in the United Kingdom after the expiration of four years from the date of the patent. If this condition is not fulfilled, any person may apply for the revocation of the patent.

Some of the results of this amendment, and some indications of the great industrial changes which it will bring about, are already obvious. Foreign firms or individuals who hold British patents and who have not sufficient capital to work them in this country, or who do not think they are worth working here, are attempting to sell their British patent rights. Others are building or buying works in Great Britain, and it has been estimated that in the immediate future a sum of at least 25,000,000*l.* of foreign capital will have been thus invested in order to comply with the new law.

We need not stop to consider the economic effects of this transfer of capital on the general trade of this country, but we may well pause a moment in order to try and forecast the consequences of these new conditions in so far as they concern our chemical industries.

The prospective establishment of branches of two of the largest German chemical works at Ellesmere Port and at Port Sunlight respectively are already matters of common

[1] *Journ. Soc. Chem. Ind.*, 1906, 1019.
[2] March 15, 1907.

knowledge, and it may be presumed that these firms will avail themselves to a large extent of British labour. If this be the case, and if they are successful—as they, no doubt, will be—the complaint that the inferior technical education of our artisans is responsible for our lack of success will thereby be proved to be groundless. Even if we admit that at the present time the British workman is an inferior operative in a chemical works, and only capable of undertaking the less-skilled labour, these firms will gradually raise a considerable number of trained men who will be ready to undertake more responsible duties under our own manufacturers when the good time comes; a school for chemical operatives will be created in our midst, and, as in the past, we shall reap the benefit of knowledge and experience brought to our shores. It also seems reasonable to expect that, as is the case abroad, these works will be equipped with laboratories and staffed by chemists, although possibly only so far as is necessary for routine work. Many of these chemists may settle permanently in our midst, become members of our Chemical Society and Society of Chemical Industry, and thus infuse us with their patience and perseverance. It is not beyond the bounds of possibility that these great firms may even employ British chemists in their works, if we can supply men sufficiently well trained to be of value. On the other hand, as experience seems to have shown that industrial chemistry cannot succeed with imported scientific labour, it is not very probable that many posts in the laboratory will be filled by our countrymen, who, in this connection, must be regarded as foreigners.

Now at the present time most chemical products can be manufactured more cheaply abroad than here, otherwise we should not have any reason to consider our position. Dr. Duisberg told us that even when an important firm in England had a licence to work all the British patents of two of the largest German colour works, merely paying for the privilege a small percentage of the net profits, it failed to take any advantage of the opportunity. If, then, in this free-trade kingdom production is cheaper than abroad, the foreign firms which have branches here will be in a position superior to that which they now occupy in their own countries. If, on the other hand, owing to inefficient labour, higher wages, freights, and other economic conditions, production is more costly, the superior efficiency and scientific organisation of these foreign firms will nevertheless enable them to command our home market with the goods made here, and to cut us out in the world market, as they do now, with those made abroad.

The conclusion which thus seems forced upon us is, that, although the new Patent Act will prove to be of great value in many respects, it will do little to foster British chemical trade and the development of British chemistry; it places us on an equality with other countries as regards patent rights, and thus remedies an outstanding grievance; but, unless we have something to patent, this equality will be valueless and our chemical industries will continue to decline, possibly more rapidly than heretofore.

Let us therefore pass in review the other causes which have been suggested as contributory to our failure; after eliminating those connected with freights and tariffs, and with the alleged supineness of the Government in assisting industry, matters which may be left to the manufacturers to deal with, there still remain several which are well within the purview of this Section.

These are: (1) the unsatisfactory condition of secondary education; (2) the nature of the training which is given to chemists in our universities and other institutions; (3) the insufficiency of the time and money devoted to research in the manufacturing industries; (4) the lack of cooperation between manufacturers and men of science.

There are some who believe that the first of these is the primary, if not the sole, cause of our weakness; that if our secondary education were placed on a sound basis all the other evils would disappear of their own accord; that a steady and broad stream of well-trained boys from the secondary schools would afford ample material from which good chemists could be fashioned in the universities and colleges; that these trained chemists would be greedily seized by the manufacturers, whose minds had been widened by improved educational methods; and once installed in the works these chemists would have no difficulty in persuading their employers to spend time and money on research work in cooperation with the leaders of science.

Whether such desirable and far-reaching results would in fact follow if our system of secondary education were very much improved it is impossible to predicate; but there is no doubt that at the present time we are moving in an exactly opposite direction.

The shadow of the cypress rests upon our chemical trade, and manufacturers do not see their way to employ chemists; students are not attracted to chemistry as a profession because there are so few openings; without an ample and increasing supply of such students chemical industry must continue to decline, and as a necessary consequence the development of pure chemistry is cramped and hindered to a far greater extent than is generally realised.

In a Presidential Address to the Chemical Society last year Prof. Meldola discussed the position and prospects of chemical research in Great Britain, and in view of the importance of the subject and the able manner in which it had been treated the Council of the Society ordered the publication of five thousand copies of his Address for distribution among the members of various public bodies. We were told in this Address that many of our universities are distinct failures as centres of chemical research, and that the output of original work from our colleges, polytechnics, and similar institutions is emphatically not representative of the productive power of the teachers there employed. The causes of the failure of our universities were only lightly touched upon, and I propose to refer to them later; but in the case of our other institutions they were more fully discussed. May I venture to direct attention to one cause, which I believe is by far the most effective drag on research in the vast majority of such institutions not of university rank? It is simply the lack of those more advanced students who, while gaining valuable experience in the methods of research, would also render useful assistance to their teacher. The governing body of the institution may not realise the importance of research; the Principal, as, alas! is sometimes the case, may throw cold water on such work; the teacher may be overburdened with routine duties, and he may be most inadequately remunerated; if, however, the research spirit is strong within him, he would overcome all these difficulties were there any prospect whatsoever of success; but what chance has he when he must do everything himself, even to washing out his own test-tubes? Provide him with a few advanced students, and he would doubtless find time to undertake the necessary pioneer research work, which would then be extended and developed with their assistance.

It might be suggested that an efficient and enthusiastic man would soon attract a number of research students. This, no doubt, is true as regards the universities, but it must be remembered that a polytechnic or other institution which does not grant degrees can hardly expect to compete with a university as a centre for research; all those students who intend to undergo a so-called "complete" course of study—that is to say, all who are likely to become capable of undertaking research work—naturally proceed to one of the degree-giving universities. There are not enough students to go round, to satisfy the research requirements of the teachers, and the principal reason is—the limited demand for trained chemists on the part of the manufacturers.

Even of the small number of those who leave our teaching institutions fairly well trained in research, how many have a chance of passing into works and directly advancing applied science? A very small proportion indeed. Most of the better ones drift into other posts, become demonstrators, emigrate—anything rather than wait on with the prospect of accepting as works-chemist a salary which, meagre though it be, may be stopped altogether if dividends are low.

With whom rests the responsibility for this state of affairs? Is it with the teachers, and, if so, is it because they are incapable of training chemists or because their system is at fault?

To answer this question it is necessary in the first place to arrive at some conclusion as to the kind of training which is required for the future works-chemist. On consulting the opinions of the manufacturers it would seem that they attach great importance to what is called the "practical side"; they believe that, in addition to a knowledge of theoretical chemistry, the prospective works-chemist should also have some acquaintance with engineering, should understand the apparatus and machinery used in the particular manufacturing operations with which he is going to deal, and should have had practical experience in working the given process. It is from this point of view that we build and equip large technological chemistry departments, such as those in the Universities of Birmingham and Leeds and in the Manchester Municipal School of Technology, departments fitted up with complete apparatus and machinery for carrying out operations on a miniature manufacturing scale.

The arguments in favour of this view, that it is a hybrid chemist-engineer who is required in a chemical works, seem to me to be fundamentally unsound, and the kind of training suggested by them for the works-chemist can only result in the production of a sort of combined analytical machine and foreman. A two or three years' course of science, followed by one year's practical work in the dye-house, in paper-making, or in some other technological department, is quite inadequate if the student trained in this way is expected to do anything beyond routine analytical work and supervision.

We cannot possibly expect such a poorly trained Jack-of-all-trades to run a chemical works successfully in the face of competition directed by a large staff of scientific experts in chemistry and in engineering. It is no use spending immense sums of money on expensive machinery of the newest type in order that the works-chemist may be able to tell his future employer that the machinery used in his employer's works is completely out of date. In the course of time, moreover, unless expenditure is practically unlimited, the reverse conditions will obtain, and the technological department of the university or other institution will become more of the nature of a museum of antiquities. The great cost of the upkeep and of the working of such plant is also a very serious matter; is it possible to believe that the educational results of running, say, a large puddling furnace, such as is fitted up in Birmingham University, are in any way commensurate with their cost? The conditions in a chemical works cannot be successfully imitated in a university or polytechnic; attempts to do so can only lead to mistaken conclusions, and thus have the effect of rendering the works-chemist quite helpless when he passes from the elegant models of his educational apparatus to the workaday appliances of the manufactory.

Here, it seems to me, we touch the bed-rock of our trouble. The state of our chemical industries must be attributed to the erroneous views which have been and still are held as to the functions, and consequently as to the training, of a works-chemist. We have failed to realise that industrial chemistry must be based on a foundation of continuous and arduous research work. In the past we have sent out from our universities and other institutions students who no doubt were qualified to undertake routine analytical work, but the great majority of whom knew nothing of the methods of research. We are doing the same to-day. Just when a student has reached a stage at which his specialised scientific training should begin his course is finished, and whether he has been to a university or to a polytechnic matters little; he joins the band of those who subsist on but who do nothing to advance chemical industry. He enters a works; the manufacturer does not realise exactly what his chemist ought to do, but he expects some immediate results, and in consequence is generally disappointed; the lack of success of the chemist is put down to his ignorance of practical matters, and there is an outcry for technical education; science is most unjustly discredited, and any suggestion of spending money on research work is scouted as a mere waste.

The consequence is that if there is a scientific problem which intimately concerns all the members of some large industry what course do they adopt? Through their trade journal, and as an association representing a total capital of which I should not like to hazard a guess, they offer a bronze or possibly a silver medal, or may even offer the extravagant sum of 20*l.*, to the happy person who will provide them with a solution. It is difficult to imagine the class of solvers to whom these princely rewards may appeal, more difficult still to believe that any useful result can be attained, and it is almost incredible that such methods should be adopted by any influential industrial organisation. This way of attempting to get research work "on the cheap" is certainly not unknown even in more enlightened countries, but that is hardly a sufficient justification for its employment.

Contrast these methods with those adopted by the Badische Anilin- und Soda-Fabrik and Meister, Lucius, and Brünig in their attempts to solve the problem of the commercial synthesis of indigo. Could there be a greater antithesis? If five thousand copies of Brunck's Paper on this subject[1] could be circulated among the manufacturers of this country—a task which might be fittingly undertaken by the Society of Chemical Industry—the study of the truly magnificent results attained by the systematic application of pure science, and of the indisputable evidence of their commercial value, might prove an object-lesson far more effective than argument for the accomplishment of a sorely needed reform.

Now if we are to meet successfully the very formidable scientific and commercial organisation opposed to us in chemical industry, we must perforce adopt the methods of our competitors; not only must we learn patience and perseverance, but we must also call to our aid the best brain-power available. We must recognise clearly that the scientific works-chemist, the only man who is likely to make discoveries of commercial value, must be thoroughly trained in the methods of research by those best qualified to do so, and we must not imagine that when he enters the works he should or could immediately become an engineer and a commercial expert; his place is in the research laboratory. The practical man—that is to say, the man who has a thorough and useful knowledge of some particular manufacturing process—must be trained under practical men in the works, and we must not imagine that a course of evening classes will convert him into an expert chemist. The ideal man who combines high scientific training and sound practical knowledge cannot be produced unless the period of his education is extended to half a life-time, and even then only through the cooperation of the chemistry teacher and the manufacturer.

Admitting the truth of these statements—and I do not think that they can be successfully controverted—we have now to consider what steps can be taken to provide these highly trained works-chemists, and to ensure for them a cordial reception on the part of the manufacturers.

The first fact which we have to bear in mind is that the great and rapid development of chemistry in recent times has lengthened the period which is required for the collegiate study of the subject. In order to acquire the necessary knowledge of facts and theory, and afterwards to devote even the minimum time to gaining experience in research methods, the future works-chemist must be prepared to continue at the university or other institution during at least five years. The course of study during the first three years might be on the lines now adopted by many of our universities for the B.Sc. pass examination, but to grant this degree in one or two subjects only, and then to call it an Honours degree, is in my opinion a serious mistake, as is also the admission of research work at this stage, both of which proceedings lead to far too early specialisation. The pass degree should be regarded merely as an indication of a sound general education in science, and the future works-chemist should then devote at least two years more to research and to special work in chemistry, on the results of which the Honours degree might be awarded. Every encouragement in the form of low fees, free admission, research scholarships, and so on, should be offered to such students, according to their merit and circumstances, in order that they may prolong their studies; the cost of these remissions or awards would not be very serious, and the money would be well spent. Teachers should then refuse to recommend, and manufacturers should refuse to employ, as a works-chemist, any student who had not passed through such a course satis-

[1] *Ber.*, 1900, i., lxxi.

factorily, unless it was understood that he was only expected to undertake routine analysis or work outside the research laboratory. By thus extending the period of training, and making research work compulsory as far as possible, a great deal would be gained; pure science would reap an immediate benefit from the investigations of the students—as has been the case abroad—and this stimulus would necessarily react on industrial chemistry; the manufacturers could be assured that they were being supplied with men of the right type; they would soon come to recognise that fact, and the demand for works-chemists would expand. In the laboratory of the works the manufacturer would then have the opportunity of gauging the capabilities and special leanings of every chemist on his staff. Those who were best fitted for directing operations in the works could be trained on the spot, as they could not possibly hope to be trained in any university or polytechnic; those who proved to be the best research chemists would, of course, remain in the laboratory working out scientific problems. Organisations of this kind could not fail to command success, and the opsonic curve of our chemical industries would soon begin to rise.

There is one institution, not a teaching body, which might greatly assist in this movement; I refer to the Institute of Chemistry of Great Britain and Ireland. This body desires and claims to represent chemistry, not only in these islands, but in all our dominions, and also to exercise some supervision or control over public appointments. It examines in chemistry and grants diplomas, and claims that its examinations are a test of practical ability rather than of theoretical knowledge. I have not a word to say against the character of these examinations, but to imagine that the Institute of Chemistry qualification is the hall-mark of a chemist is ridiculous. An average student can obtain the diploma after three, or at the very most four, years' work subsequent to matriculation, and more easily than the London B.Sc. (external). Here, again, it should be recognised that the present Institute of Chemistry qualification is only a step in the training of a chemist; the permission to present a thesis for the Associate examination should be withdrawn, and good research work should be insisted on in the case of all candidates for the Fellowship. It would then be possible to distinguish between those who are capable routine chemists and those who might be expected to advance pure and applied science. It is certainly a grave matter for an Institution entirely controlled by chemists to set such a bad example by ignoring the necessity of research work; if all our official chemical appointments and many of our posts in works are to be filled by men who have done no independent scientific work, the results will be most serious; the research habit and the research method are not easily acquired without assistance, and therefore it is all the more important to make use of this assistance while it is within reach, and before the budding chemist begins to believe that he has nothing more to learn.

As a necessary corollary to making research compulsory in the training of works-chemists, all our important teaching institutions must afford ample opportunities for such work, and measures must be adopted to guard against that failure of some of our universities as centres of research which was pointed out by Prof. Meldola.

Such failure, whatever may be the contributory causes, must be principally due to the absence of sufficient interest in research work on the part of the professor, and it certainly seems surprising, at first sight, that in these days many such professors are to be found; but it must be remembered that although by members of this Section research work is regarded as the highest and most important of all professorial duties, this is not always the view of those who make an appointment to a Chair.

In selecting a professor there are many other considerations which come into play: his ability as a teacher in the class-room and laboratory; his qualifications as a popular exponent of science; his power of organisation; his bearing towards his colleagues and his students—all these matters are of great and direct importance to a university, and it is not to be wondered at that a man highly qualified in these accessories may sometimes be chosen even though he may take no special interest in research work.

The results of such an appointment, however, cannot fail to be most prejudicial to the highest interests of the university and of the country; the chemistry department becomes a chemistry school, but not a school of chemistry.

Unfortunately, moreover, the results extend over a long period: this raises another question which certainly requires attention if we are to become more efficient.

It is far from my object to create any gratuitous insecurity of tenure in chairs of chemistry, but is it not desirable that in our teaching institutions the conditions of all appointments should include a superannuation clause? Not that a rigid age-limit should be introduced, but there should be a possibility of bringing about the retirement of those who for any reason can no longer adequately fulfil their duties. When, owing to the lapse of time, such retirement became necessary, the aged and honoured professor, pensioned by a grateful university, might still retain an intimate connection with its scientific life; as emeritus professor, with a research laboratory at his disposal, he might remain to advise and encourage his youthful successor even when the duties of teaching and the general supervision of a department had become too arduous.

It cannot be suggested that my remarks on this delicate topic are inspired by the impatience of youth or by freedom from personal consequences; the time when superannuation becomes desirable may arrive for one and all, and I have ventured to direct attention to the matter simply and solely because of its grave importance in connection with the subject of my Address. The country cannot afford to allow periods of inactivity or decadence in our seats of learning, and the interests of the individual must be subordinated to those of the nation.

Even if by adopting the above suggestions the training of our chemists is improved, and all our higher educational institutions become permanent and active centres of research, the manufacturers may still remain unresponsive, what can be done in other ways to bring about the active cooperation of pure and applied science?

The great proportion of the original work now done in this country, judging from the published records, is absolutely free from any utilitarian bias; the time, brain-power, and money devoted to this work are considerable, and the results from a scientific point of view eminently satisfactory. If even a fraction of the same skill and energy were brought to bear under proper conditions on problems of applied science, who can doubt but that the effect on our chemical industries would be one of vast importance? And yet it is the rarest possible occurrence to find any record of research work undertaken with a commercial object even in the natural home of such records, the Journal of the Society of Chemical Industry.

One reason for this may be that the discoveries made in the works-laboratories are not given to the world at large, but are quietly and lucratively applied in some secret manufacturing process. Another reason, unfortunately the more probable one, may be that nearly all the principal research workers are completely shut off from any industrial influences.

Now the worker in pure science, unaided by the advice of the manufacturer and business man, has little chance of solving any important technological problem, except as the result of accident; he has not the requisite acquaintance with commercial conditions, does not realise the enormous difference between operations on the laboratory and the manufacturing scales, or, if he does so, is unable to enter fully and with confidence into questions of fuel, labour, and so on which often determine the success or otherwise of a process. Further, much of the research work of direct commercial value concerns methods for reducing the cost of processes already in operation, and demands an intimate practical knowledge of these processes.

It is obvious, therefore, that, even if all the research capacity of the country were henceforth devoted to purely technical matters, any great improvement in our industries could hardly be anticipated without the active cooperation of the manufacturers.

Now it has been stated [1] that the authorities of the Manchester Municipal School of Technology intend to under-

[1] Levinstein, *Journ. Soc. Chem. Ind.*, 1903, 845.

take investigations for local manufacturers and merchants in connection with difficulties which may be met with in their works or business. This method of securing the interest and support of those engaged in applied chemistry may or may not be workable according to the conditions under which such cooperation is carried out. The staff and the laboratories of a university or polytechnic cannot be placed at the unrestrained and gratuitous disposal of any manufacturer who is in some trivial difficulty, nor can the choice of the subjects to be investigated be decided by the governing body. If however the arrangements, pecuniary and otherwise, are left entirely in the hands of those directly concerned, namely, the manufacturer and the responsible head of the chemistry department, the scheme should then prove exceedingly valuable, and should be adopted as widely as possible. It should be understood, and the fact might even be advertised by the governing body, that for purposes of research work in applied chemistry—but not of course for analytical work—the laboratory of the university, college, or polytechnic is, under certain conditions, at the service of the manufacturers; that although primarily and unswervingly devoted to work in pure science, such institutions recognise that, for their own interests, they must do all they can to assist chemical industries.

It might be thought that these conditions prevail at the present time, and that any manufacturer, if he so choose, may consult the university staff on any problem in which he is interested. Possibly this is true to a limited extent, but in most institutions the members of the staff are restrained from undertaking any outside work; in others, such work may only be done with the sanction of the authorities.

These conditions, of course, are only laid down because the governing body believes that they safeguard the interests of the institution, and if it were shown that their enforcement is really contrary to those interests they would soon be abrogated. Many or all such authorities readily permit the members of their staff to undertake outside examination work because they consider this course to be to the advantage of their institution; but how incomparably more important is the object of gaining the confidence and support of the manufacturers.

Pray do not let it be imagined that this is some subtle scheme for increasing the pecuniary rewards of the teachers. I greatly fear that to many of those who are now engaged in research work the suggestion that they should give some attention to applied chemistry would be very distasteful, simply because it would involve an immediate encroachment on the time, already far too limited, which they are able to give to the immediate scientific problem which is one of their principal joys in life. To those who might have fears of this kind I would point out that there would soon be some compensation; once the cooperation of the manufacturers is secured, the demand for research chemists would expand, and the laboratories would be filled with students whose help in pure science would be invaluable.

The possible objection that the teaching staff would devote too much time to applied work and neglect other duties is one which could be left for the governing body to deal with unsparingly. If the institution took some percentage of all extraneous remuneration, or any similar arrangement were made, the funds thus provided could be used for increasing the staff of assistants and demonstrators—a most desirable reform in itself.

One of the greatest advantages of a working arrangement such as that here indicated would be that, like the method already suggested, it would lead to the evolution of what is otherwise almost unattainable—namely, men thoroughly trained in both science and practice. The research students of the teaching institution, engaged on a given problem for a manufacturer, would of course be allowed to study its practical aspects in the works; on the other hand, works-chemists, with considerable practical experience, would be granted permission to proceed to the university laboratory, where they would study the problem with the assistance of the highest scientific knowledge, and acquire further training in the methods of research.

Combinations such as these could hardly fail to lead to valuable results, which would form the subject of patents; the monopolies thus acquired would place the manufacturers in a favourable position, and the revival of our chemical industries would follow in due course. There is nothing Utopian in this scheme, and there are no great initial difficulties to be overcome; it may be set in operation by the manufacturer, and possibly also, as will be indicated later, by the worker in pure science. Reading between the lines certain records which have recently appeared in the science journals and the patent lists, it may even be inferred that such arrangements are already in force in one of our large industrial centres.

There are other ways in which it might be possible to obtain the active cooperation of the manufacturers. Any individual or firm interested in a problem of applied science might be invited to found a temporary research scholarship at the university or other institution for the definite object of the particular problem in question. The maximum period during which such a scholarship would be tenable might be fixed beforehand, so that the financial liability of the founder would be limited and proportionate to the importance of the object in view. The holder of the scholarship might be nominated by the university, or by the founder and the university jointly, and suitable conditions would be drawn up to ensure the interests of the founder; he would of course have the benefit of all the results of the work, and would secure the patent rights of any new invention, subject possibly to the payment of a small percentage of the profits to the university and to the holder of the scholarship. During the tenure of the scholarship, the holder, and also the founder, would have the advantage of the scientific knowledge of the university; the scholarship holder would also be allowed to gain practical experience in the works, and, if successful, there is little doubt but that he would have the option of working the process on the large scale and of obtaining permanent employment under satisfactory conditions. After a given period the scientific results of the work would be published through the usual channels in the ordinary way.

This idea of applied research scholarships had taken shape in my mind when I happened to come across a book recently published in the United States, called "The Chemistry of Commerce," in which I found that a similar proposal had been made by the author, R. K. Duncan, Professor of Industrial Chemistry at the University of Kansas. The scheme is there worked out in some detail, and a form of legal agreement to be signed by the university authorities and by the founder of the "Industrial Fellowship" is suggested.

Thinking it would be of interest to know how the plan had worked out in practice, I wrote to Prof. Duncan and received a reply a few weeks ago. He very courteously informed me that five industrial fellowships had already been established in his laboratories, that the agreements for two additional ones were being prepared, and that he might have obtained more, but wished to proceed conservatively; also that he had no reason to doubt the entire practicability of the scheme, and that experience had shown that the terms of the agreement could be made more favourable to the university than those which were first drawn up. One of the new conditions is that the industrial fellowship holder shall give two hours a week gratuitous instruction in the work of the chemistry department—an arrangement which has proved to be of great inspirational value. The fellowships are tenable during two years, and are of the value of 500 dollars or 1000 dollars per annum.

It is too soon to be able to form any opinion as to the commercial importance of the work carried out under this scheme, but it is obvious that the foundation of such scholarships for the study of general or special problems in applied chemistry is most desirable. One of their great advantages would be that they might be founded by those manufacturers who cannot afford permanently to engage a research chemist. Large and successful firms like the United Alkali Co., Brunner, Mond and Co., and many others which can employ a staff of chemists, are of course eminently capable of managing their own affairs without outside assistance or advice, and it is only for those which are less prosperous that the foregoing suggestions are made.

The great benefits which are conferred on pure science by the open research scholarships at present available afford some indication of what might be done for industrial chemistry by the foundation of such scholarships in applied science. There are, no doubt, scattered over the country many men who possess originality and inventive talent, and who have practical experience in industrial operations, but who have not been sufficiently trained in science; if it were possible to attract this dormant talent by means of open scholarships it might be directed into proper channels instead of being allowed to run to waste.

It is easy to say how money might be spent advantageously, but very difficult to suggest how the funds for such open scholarships should be raised. An appeal to the manufacturers by this Association or by the Society of Chemical Industry might meet with some response, and it is also possible that public bodies might render assistance. If the Government of Bengal, under the spur of dire necessity, can subsidise research work on indigo, and if our county councils can offer scholarships for dairy work, and grants for experiments on turnip-growing, bee-keeping, and so on, our city and borough councils might award scholarships in applied chemistry for subjects of especial importance to the dominant trades of the district. By so doing they would be utilising to the best advantage the chemistry departments of our universities and polytechnics.

I noted a few moments ago that practically all the published research work of this country has no direct reference to any industrial problem; nevertheless the results of this work are often of such a character that they might be of considerable technological importance. New reactions are discovered; new or improved methods of preparing known compounds; new facts as to the conditions under which important general reactions occur; and, needless to add, a great many new compounds are prepared.

Now, abroad, all or nearly all such matters are protected by patents, generally taken out by some firm of manufacturers. To the uninitiated it seems absurd to think that there is money in the great majority of such patents, and yet it is obvious that the employment of this system must pay in the long run. Why should it not be adopted in this country—at any rate to a limited extent to start with?

If all those who are engaged in purely scientific research work would seriously consider the desirability of obtaining provisional protection for any discovery which they may make, and would then consult some manufacturer or industrial expert with whom the further development of the matter might be undertaken, there is reason to believe that in some cases at least the patent might prove to be a commercial success.

The examination of the therapeutic action of compounds discovered in our laboratories is also a possible means of assisting our chemical industries; the matter is not so trivial as it may seem; a monopoly in the manufacture of some valuable medicinal preparation would serve as a *point d'appui* from which more important operations could be undertaken.

Unfortunately the investigation of the physiological action of new preparations is a matter of some difficulty in this country, as it is to some extent connected with vivisection in the public mind; we may poison rats with impunity, and even create an organisation for their extermination, but we may not individually try the effect of a new compound on a rabbit.

In drawing this Address to a conclusion I cannot but feel that my suggestions may seem utterly inadequate to the attainment of those important results which are so greatly to be desired. If so, I can only plead that more drastic measures are hardly available, and that even in the most favourable circumstances improvement can take place only very slowly. Whatever differences of opinion may be held as to the details of any scheme for regaining our lost ground, the main lines seem to be clearly indicated. The workers in pure science must recognise that it is their duty to do all they can to promote the industrial welfare of their country; the manufacturers must concede the paramount importance of science and the impossibility of dispensing with its counsels. Guided by these principles and by a spirit of cordial cooperation, a sustained and strenuous effort on the part of the leaders of chemical industry and of chemical science can hardly fail to accomplish the end in view.

In elaborating this Address I have enjoyed the advantage of the criticisms and suggestions of my friend and relative Prof. Perkin, F.R.S., to whom my sincere thanks are here expressed.

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## SECTION C.

### GEOLOGY.

OPENING ADDRESS BY PROF. JOHN JOLY, M.A., D.Sc., F.R.S., PRESIDENT OF THE SECTION.

### URANIUM AND GEOLOGY.

#### *Introduction.*

In our day but little time elapses between the discovery and its application. Our starting-point is as recent as the year 1903, when Paul Curie and Laborde showed experimentally that radium steadily maintains its temperature above its surroundings. As in the case of many other momentous discoveries, prediction and even calculation had preceded it. Rutherford and McClung, two years before the date of the experiment, had calculated the heat equivalent of the ionisation effected by uranium, radium, and thorium. Even at this date (1903) there was much to go upon, and ideas as to the cosmic influence of radio-activity were not slow in spreading.[1]

I am sure that but few among those whom I am addressing have seen a thermometer rising under the influence of a few centigrams of a radium salt; but for those who pay due respect to the principles of thermodynamics, the mere fact that at any moment the gold leaves of the electroscope may be set in motion by a trace of radium, or, better still, the perpetual motion of Strutt's "radium clock," is all that is required as demonstration of the ceaseless outflow of energy attending the events proceeding within the atomic systems.

Although the term "ceaseless" is justified in comparison with our own span of existence, the radium clock will in point of fact run down, and the heat outflow gradually diminish. Next year there will be less energy forthcoming to drive the clock, and less heat given off by the radium by about the one three-thousandth part of what now are evolved. As geologists accustomed to deal with millions of years, we must conclude that these actions, so far from being ceaseless, are ephemeral indeed, and that if importance is to be ascribed to radium as a geological agent, we must seek to find if the radium now perishing off the earth is not made good by some more enduringly active substance.

That uranium is the primary source of supply cannot be regarded as a matter of inference only. The recent discovery of ionium by Boltwood serves to link uranium and radium, and explains why it was that those who sought for radium as the immediate offspring of uranium found the latter apparently unproductive, the actual relation of uranium to radium being that of grandparent. But even were we without this connected knowledge, the fact of the invariable occurrence in Nature of these elements, not only in association but in a quantitative relationship, can only be explained on a genetic connection between the two. This evidence, mainly due to the work of Boltwood, when examined in detail, becomes overwhelmingly convincing.

Thus it is to uranium that we look for the continuance of the supplies of radium. In it we find an all but eternal source. The fraction of this substance which decays each year, or, rather, is transformed to a lower atomic weight, is measured in tens of thousands of millionths; so that the uranium of the earth one hundred million years ago was hardly more than 1 per cent. greater in mass than it is to-day.

As radio-active investigations became more refined and extended, it was discovered that radium was widely diffused over the earth. The emanation of it was obtained from the atmosphere, from the soil, from caves. It was

[1] See letters appearing in NATURE of July 9 and September 24, 1903, from the late Mr. W. E. Wilson and Sir George Darwin referring to radium as a solar constituent, and one from the writer (October 1, 1903) on its influence as a terrestrial constituent.

extracted from well waters. Radium was found in brick-earths, and everywhere in rocks containing the least trace of demonstrable uranium, and Rutherford calculated that a quantity of radium so minute as $4·6 \times 10^{-11}$ grams per gram of the earth's mass would compensate for all the heat now passing out through its surface as determined by the average temperature gradients. In 1906 the Hon. R. J. Strutt, to whom geology owes so much, not only here but in other lines of advance, was able to announce, from a systematic examination of rocks and minerals from various parts of the world, that the average quantity of radium per gram was many times in excess of what Rutherford estimated as adequate to account for terrestrial heat-loss. The only inference possible was that the surface radium was not an indication of what was distributed throughout the mass of the earth, and, as you all know, Strutt suggested a world deriving its internal temperature from a radium jacket some 45 miles in thickness, the interior being free from radium.[1]

My own experimental work, begun in 1904, was laid aside until after Mr. Strutt's paper had appeared, and a valued correspondence with its distinguished author was permitted to me. This address will be concerned with the application of my results to questions of geological dynamics.

Did time permit I would, indeed, like to dwell for a little on the practical aspect of measurements as yet so little used or understood; for the difficulties to be overcome are considerable, and the precautions to be taken many. The quantities dealt with are astoundingly minute, and to extract with completeness a total of a few billionths of a cubic millimetre of the radio-active gas—the emanation—from perhaps half a litre or more of a solution rich in dissolved substances cannot be regarded as an operation exempt from possibility of error; and errors of deficiency are accordingly frequently met with.

Special difficulties, too, arise when dealing with certain classes of rocks. For in some rocks the radium is not uniformly diffused, but is concentrated in radio-active substances. We are in these cases assailed with all the troubles which beset the assayer of gold who is at a loss to determine the average yield of a rock wherein the ore is sporadically distributed. In the case of radium determinations this difficulty may be so much the more intensified as the isolated quantities involved are the more minute and yet the more potent to affect the result of any one experiment. There is here a source of discrepancy in successive experiments upon those rocks in which, from metamorphic or other actions, a segregation of the uranium has taken place. With such rocks the divergences between successive results are often considerable, and only by multiplying the number of experiments can we hope to obtain fair indications of the average radio-activity. It is noteworthy that these variations do not, so far as my observations extend, present themselves when we deal with a recent marine sediment or with certain unaltered deposits wherein there has been no readjustment of the original fine state of subdivision, and even distribution, which attended the precipitation of the uranium in the process of sedimentation.

But the difficulties attending the estimation of radium in rocks and other materials leave still a large balance of certainty—so far as the word is allowable when applied to the ever-widening views of science—upon which to base our deductions. The emanation of radium is most characteristic in behaviour; knowledge of its peculiarities enables us to distinguish its presence in the electroscope not only from the emanation of other radio-active elements, but from any accidental leakage or inductive disturbance of the instrument. The method of measurement is purely comparative. The cardinal facts upon the strength of which we associate radium with geological dynamics, its development of heat and its association with uranium, are founded in the first case directly on observation, and, in the second, on evidence so strong as to be equally convincing. Recent work on the question of the influence of conditions of extreme pressures and temperatures on the radio-active properties of radium appear to show that, as would be anticipated, the effect is small, if indeed existent. As observed by Makower and Rutherford, the small diminution noticed under very extreme conditions in the $\gamma$ radiation possibly admits of explanation on indirect effects. These observations appear to leave us a free hand as regards radio-thermal effects unless when we pursue speculations into the remoter depths of the earth, and even there while they remain as a reservation, they by no means forbid us to go on.

The precise quantity of heat to which radium gives rise, or, rather, which its presence entails, cannot be said to be known to within a small percentage, for the thermal equivalent of the radio-active energy of uranium, actinium, and ionium, and of those members of the radium family which are slow in changing, has not been measured directly. Prof. Rutherford has supplied me, however, with the calculated amount of the aggregate heat energy liberated per second by all these bodies. In the applications to which I shall presently have to refer I take his estimate of $5·6 \times 10^{-2}$ calories per second as the constant of heat-production attending the presence of one gram of elemental radium.

To these words of introduction I have to add the remark, perhaps obvious, that the full and ultimate analysis of the many geological questions arising out of the presence of radium in the earth's surface materials will require to be founded upon a broader basis than is afforded by even a few hundred experiments. The whole sequence of sediments has to be systematically examined; the various classes of igneous materials, more especially the successive ejecta of volcanoes, fully investigated. The conditions of entry of uranium into the oceanic deposits have to be studied, and observations on sea-water and deep-sea sediments multiplied. All this work is for the future; as yet but little has been accomplished.

*The Radium in the Rocks and in the Ocean.*

The fact first established by Strutt that the radium distributed through the rock materials of the earth's surface greatly exceeds any permissible estimate of its internal radio-activity has not as yet received any explanation. It might indeed be truly said that the concentration of the heaviest element known to us (uranium) at the surface of the earth is just what we should not have expected. Yet a simple enough explanation may be at hand in the heat-producing capacity of that substance. If it was originally scattered through the earth-stuff, not in a uniform distribution, but to some extent concentrated fortuitously in a manner depending on the origin of terrestrial ingredients, then these radio-active nuclei heating and expanding beyond the capacity of surrounding materials would rise to the surface of a world in which convective actions were still possible and, very conceivably, even after such conditions had ceased to be general; and in this way the surface materials would become richer than the interior. For instance, the extruded mass of the Deccan basalt would fill a sphere 36 miles in radius. Imagine such a sphere located originally somewhere deep beneath the surface of the earth surrounded by materials of like density. The ultimate excess of temperature, due to its uranium, attained at the central parts would amount to about 1000° C., or such lesser temperature as convective effects within the mass would permit. This might take some thirty million years to come about, but before so great an excess of temperature was reached the force of buoyancy developed in virtue of its thermal expansion must inevitably bring the entire mass to the surface. This reasoning would, at any rate, apply to material situated at a considerable distance inwards, and may possibly be connected with vulcanicity and other crustal disturbances observed at the surface.[1] The other view, that the addition of uranium to the earth was mainly an event subsequent to its formation in bulk, so that radio-active substances were added from without and, possibly, from a solar or cosmic source, has not the same *à priori* probability in its favour.[2]

I have in this part of my address briefly to place before you an account of my experiments on the amounts of radium distributed in surface materials. Here, indeed, direct knowledge is attainable; but this knowledge takes us but a very few miles inwards towards the centre of the earth.

[1] Proc. R.S., lxxvii., p. 472, and lxxviii., p. 150.

[1] See Appendix A.

[2] NATURE, lxxv., p. 294.

*The Igneous Rocks.*—The basalt of the Deccan, to which I have referred, known to cover some 200,000 square miles to a depth of from 4000 to 6000 feet or more, appears to be radio-active throughout. A fine series of tunnel and surface specimens sent to me by the Director of the Indian Geological Survey has enabled me to examine the radio-activity at various points. It is remarkable that the mean result does not depart much from that afforded by a long series of experiments on North of Ireland basalt and on the basalt of Greenland.

Again, the granites and syenites—and those of Mourne, Aberdeen, Leinster, Plauen, Finsteraarhorn have been examined—while variable, yet approximate to the same mean result.

In the Simplon and St. Gothard tunnels igneous rocks have been penetrated at considerable depth beneath the surface. The greatest true depth is attained, I think, in the central St. Gothard massif. It is remarkable, and may be significant, that in these rocks I have reached the lowest radio-activities I have met—down to almost one-billionth of a gram of radium per gram; although the general mean of the St. Gothard igneous rocks, owing to the high radio-activity of the Finsteraar granite at the north end of the tunnel, is not exceptionally low. Radio-active minerals seem common in the Simplon rocks, involving considerable variations in successive experiments. Some of the highest results are omitted in the mean given below, but as it is difficult to know what to allow for purely sporadic radium the mean is not very certain. In the case of a specially high result I asked Prof. Emil Werner to determine the uranium: my result was confirmed. My list of mean results on igneous rocks up to the present is the following:—

| | | | |
|---|---|---|---|
| Basalts (14) ... ... | 5·0[1] | Lewisian Gneiss (3). | 5·7 |
| Granites (6) ... ... | 4·1 | Simplon (32) ... ... | 7·6 |
| Syenites (1) ... ... | 6·8 | St. Gothard (32) ... | 5·1 |

The general mean is 6·1.

From the igneous rocks have originated the sediments after a toll of dissolved substances has been paid to the ocean. It does not of course follow necessarily that the percentage of radium, or more correctly of uranium, in the sedimentary rocks should be less than in the igneous. The residual materials might keep the original percentage of the parent rock, or even improve upon it. There are reasons for believing, however, that there would be a diminution.

Those sedimentary rocks which have been derived from materials formerly in solution offer a different problem. In their case there is little or none of the original materials carried into the secondary rock, and the radio-activity will depend mainly upon how far uranium is precipitated or abstracted with the rock-making substances. In other words, upon how far the waters of the ocean will restore to the rocks what it has borrowed from them.

This brings me to consider the condition of the ocean as preparatory to quoting experiments on the sediments.

*The Ocean and its Sediments.*—The waters of the ocean, covering five-sevenths of the earth's surface to a mean depth of 3·8 kilometres, represent the most abundant surface material open to our investigation. As the mean of a very large number of experiments upon twenty-two different samples of sea-water from various widely separated parts of the ocean, I obtain a mean of $0{\cdot}016 \times 10^{-12}$ gram per cubic centimetre. There is considerable variability. Taking the mass of the ocean as $1{\cdot}458 \times 10^{18}$ tonnes, there must be about $20 \times 10^{9}$ grams (20,000 tons) of radium in its waters.

The experiments which I have been able to make on deep-sea deposits, thanks mainly to the kind cooperation of Sir John Murray, apply to ten different materials of typical character.

The results are so consistent as to lead me to believe that although so few in number they cannot be far wrong in their general teaching.

[1] This number is to be multiplied by $10^{-12}$, and represents billionths of a gram of radium per gram of material investigated. Throughout the rest of my address this understanding holds, unless where a different meaning is specified. The numbers in parentheses signify the number of different specimens investigated.

The means are:—

| | Radium | Extension: Millions of square miles |
|---|---|---|
| Globigerina Ooze ... ... | 7·2 | 49·5 |
| Radiolarian ,, ... ... | 36·7 | 2·5 |
| Red Clay ... ... ... ... | 33·3 | 51·5 |

Diatom Oozes have not yet been examined.

It is apparent from these results that the more slowly collecting sediments are those of highest radio-activity, as if the organic materials raining downwards from the surface of the ocean carried everywhere to the depths uranium and radium abstracted from the waters, but in those regions where the conditions were inimical to the preservation of the associated calcareous tests there was the less dilution of the radio-active substances accumulating beneath. The next table shows that radio-activity and the percentage of calcareous matter in these deposits stand in an inverse relation:—

| | | Calcium carbonate per cent. | Radium |
|---|---|---|---|
| Globigerina Ooze, *Challenger* | 338 | 92·24 | 6·7 |
| ,, ,, ,, | 290 | 64·34 | 7·4 |
| Red Clay ... ... ,, | 5 | 12·00 | 15·4 |
| ,, ... ... ,, | 276 | 28·28 | 52·6 |
| Radiolarian Ooze ,, | 272 | 10·19 | 22·8 |
| ,, ,, ,, | 274 | 3·89 | 50·3 |

The percentages of calcium carbonate are from the Report of the *Challenger* Expedition. The Red Clay in the table, which reads as an apparent exception, is probably a case of recent change in the character of the deposit, for the evidence of manganese nodules and sharks' teeth brought up with this clay is conclusive as to the slow rate of its collection. Readers of Sir John Murray's and Prof. Renard's report will remember many cases where recent change in the character of a deposit is to be inferred.

A point of much importance in connection with our views on oceanic radio-activity is that of the presence in the waters and in the deposits of the parent radio-active substance, uranium. The evidence that the full equivalent amount of uranium is present is, I believe, conclusive.

In the first place, to so vast a reservoir as the ocean the rivers cannot be supposed to supply the radium sufficiently fast to make good the decay. In a very few thousand years, in the absence of uranium, the rivers must necessarily renew almost the entire amount of radium present. I have made examination of the water of one great river only—the Nile. The quantity of radium detected was $0{\cdot}0042 \times 10^{-12}$ per cubic centimetre. That is less than the oceanic amount. In short, it is evident that the uranium must accumulate year by year in the oceanic reservoir, like other substances brought in by the rivers, and that the present state of the waters is the result of such actions prolonged over geological time.

While this reasoning is conclusive as regards the waters of the ocean, it does not assure us that the sediments accumulating in their depths are throughout as radio-active as their surface parts would indicate. There might be a precipitation of radium unattended by uranium, in which case their deeper parts would not be radio-active.

Against this possibility there is the evidence of such true deep-sea deposits as were formed in past times and to-day still preserve their radio-activity. For instance, the chalk, which, considering that it was undoubtedly a very rapidly formed deposit, exhibits a radio-activity quite comparable with that of the Globigerina Oozes, deposits which it most nearly resembles. In this deposit, clearly, the uranium must have collected along with the calcareous materials. We can with security argue that the similar oozes collected to-day must likewise contain uranium. In the case of the Red Clays we have the direct determination of the uranium which Prof. Emil Werner was so good as to make at my request. Considering the difficulties attending its separation, the result must be taken as supporting the view that here, too, the radium is renewed from the uranium. Regarding the efforts of other observers to detect uranium in such deposits, it is noteworthy that without the guidance of the radium, enabling specially rich materials to be selected for analysis, the success of the investigation must have been doubtful. The material used was a Red Clay with the relatively large quantity of 54·4 billionths of a gram per gram. In a few grams of this Werner obtained up to seven-twelfths of the total theoretic amount, and of course the separation of the uranium is not likely to have been complete.

It might be thought a hopeless task to offer any estimate of the total bulk of the sub-oceanic deposits, and from this to arrive at some idea of the quantity of radium therein contained. Nevertheless, such an estimate is not only possible, but is based on deductions which possess considerable security. As a major limit I believe the estimate of the total mass of deposit is unassailable, and such deductions as might be applied will still leave it an approximation to the truth.

The elements of the problem are simple enough; we know that the sedimentary rocks have been derived from the igneous, some 30 per cent. of the latter entering into solution in the process of conversion. Some of the soluble constituents, owing to their great solubility, have remained in solution since they entered the ocean.[1] These are the salts of sodium. An estimate of the amount of these salts in the ocean gives us a clue to the total amount of rock substance which has contributed to oceanic salts and oceanic deposits since the inception of the oceans. Some years ago I deduced on this basis that the igneous rocks which are parent to the sodium in the sea must have amounted to about $91 \times 10^{16}$ tons.[2] This figure in no way involves the rate of supply by the rivers, or our estimate of geological time. It only involves the quantity of sodium now in the ocean—a fairly well-known factor—and the loss of this element, which occurs when average igneous rocks are degraded into sedimentary rocks—a factor also fairly well known. Mr. F. W. Clark, to whom geological science is indebted for so much exact investigation, has recently repeated this calculation, using data deduced anew by himself, and arrives at the result that the bulk of the parent igneous rock was $84{\cdot}3 \times 10^6$ cubic miles.[3] On a specific gravity of 2·6 my estimate in tons gives nearly the same result: $84 \times 10^6$ cubic miles.

Now about one-third part of this parent rock goes into solution when breaking up into a detrital sediment. The limestones upon the land are part of what was once so brought into solution. Having made deduction of these former marine deposits (and I here avail myself of Van Hise's and Clark's estimates of the total amount of the sedimentaries and the fraction of these which are calcareous),[4] and, allowing for the quantity remaining in solution in the ocean, the result leaves us with the approximation of twenty million cubic miles of matter once in solution, and now for the greater part existing as precipitated or abstracted deposits at the bottom of the ocean. We are to distribute this quantity over its floor. If the rate of collection had been uniform in every part of the ocean throughout geological time, a depth of about one-seventh of a mile (240 metres) of deposit would cover the ocean bed.

While, I believe, we can place considerable reliance on this approximation, we are less sure when we attempt an estimate of its mean radio-activity. If we assume for it an average radio-activity similar to that of Globigerina Ooze, we find that the quantity of radium involved must be considerably more than a million tons. Apart from the value which such estimates possess as presenting us with a perspective view of the great phenomena we are dealing with, it will now be seen that it supports the finding of the experiments on sedimentary rocks, and leads us to anticipate a real difference in the radio-activity of the two classes of material.

*The Sedimentary Rocks.*—The radium content of those of detrital character is indicated in the following sandstones, slates, and shales:—

| | |
|---|---|
| Shales, sandstones, grits (10) ... ... ... ... ... | 4·4 |
| Slates (Cambrian, Devonian) ... ... ... ... ... | 4·7 |
| Mud from Amazon ... .. ... ... ... ... ... ... | 3·2 |

Some of the above are from deep borings in Carboniferous rocks (the Balfour and Burnlip bores),[1] and from their nature, where not actually of fresh-water origin, can owe little to oceanic radio-activity. Many of the following belong to the class of precipitates, and therefore owe their uranium wholly or in part to oceanic source:—

| | |
|---|---|
| Marsupites chalk ... ... ... ... ... ... ... ... | 4·2 |
| Green sandstone ... ... ... ... ... ... ... ... | 4·9 |
| Green sand (dredged) ... ... ... ... ... ... ... | 4·5 |
| Limestones and dolomites [Trenton, Carboniferous, Zechstein, Lias, Solenhofen (7)] ... ... | 4·1 |
| Keuper gypsum ... ... ... ... ... ... ... ... | 6·9 |
| Coral rock, Funafuti bore (4)[2] ... ... ... ... | 1·7 |
| Trias-Jura sediments, Simplon: 17 rocks of various characters ... ... .. ... ... ... | 6·9 |
| Mesozoic sediments, St. Gothard: 19 rocks of various characters ... ... ... ... ... ... | 4·2 |

The general mean on sixty-two rocks is 4·7.

Making some allowance for uncertainties in dealing with the Simplon rocks, I think the experiments may be taken as pointing to the result:—

Igneous rocks from 5 to 6.
Sedimentary rocks from 4 to 5.

If our estimate of oceanic radium be applied to the account of the sedimentary rocks in a manner which will be understood from what I have already endeavoured to convey, there will be found to exist a fair degree of harmony between the great quantities which we have found to be in the sediments of the ocean and the impoverishment of the sediments which the experiments appear to indicate.

In all these results fresh and unweathered material has been used. The sand of the Arabian desert gave me but 0·4. Similarly low results have been found by others for soils and such materials. These are not to be included when we seek the radio-activity of the rocks.

As regards generally my experiments on the radium-content of the rocks, I cannot say with confidence that there is anything to indicate a definite falling off in radio-activity in the more deeply seated materials I have dealt with. The central St. Gothard and certain parts of the Deccan have given results in favour of such a decrease. On the other hand, as will be seen later, the granite at the north end of the St. Gothard and the primitive gneiss of the Simplon show no diminution. According to the view I have put forward above as to the origin of the surface richness in radium it is, I think, to be expected that, while the richest materials would probably rise most nearly to the surface, there might be considerable variability in the radio-activity of the deeper parts of the upper crust.

### *Uranium and the Internal Heat of the Earth.*

While forced to deny of the earth's interior any such richness in radium as prevails near the surface, the inference that uranium exists yet in small quantities far down in the materials of the globe is highly probable. This view is supported by the presence of radium in meteoric substances and by its very probable presence in the sun—that greatest of meteorites. True, the radio-thermal theory cannot be supposed to account for any great part of solar heat unless we are prepared to believe that a very large percentage of uranium can be present in the sun, and yet yield but feeble spectroscopic evidence of its existence. Taken all together, the case stands thus as regards the earth. We are assured of radium as a widely distributed surface material, and to such depths as we can penetrate. By inference from the presence of radium in meteoric substances and its very probable presence in the sun, from which the whole of terrestrial stuff probably originated, as well as by the inherent likelihood that every element at the surface is in some measure distributed throughout the entire mass, we arrive at the conclusion that radium is indeed a universal terrestrial constituent.

The dependent question then confronts us—Are we living on a world heated throughout by radio-thermal actions? This question—one of the most interesting which has

[1] Trans. Royal Dublin Soc., vol. vii., ser. ii., p. 23 *et seq.*
[2] *Ibid.*, p. 46.
[3] "The Data of Geochemistry," by F. W. Clark, p. 29.
[4] *Ibid.*, p. 31.

[1] For these rocks, and for much other valuable material, I have to thank Mr. D. Tate, of the Scottish Geological Survey.
[2] For these I have to thank the Trustees of the British Museum and Mr. A. S. Woodward, F.R.S.

originated in the discovery that internal atomic changes may prove a source of heat—can only be answered (if it can be answered at all) by the facts of geological science.

I will not stop to discuss the evidence for and against a highly heated interior of the earth. I assume this heated interior as the obvious and natural interpretation of a large class of geological phenomena, and pass on to consider certain limitations to our knowledge which have to be recognised before we are in a position to enter on the somewhat treacherous ground of hypotheses.

In the first place, we appear debarred from assuming that the surface and central interior of the earth are in thermal connection, for it seems certain that, since the remote period when (probable) convective effects became arrested by reason of increasing viscosity, the thermal relations of the surface and interior have become dependent solely on conductivity. From this it follows if the state of matter in the interior is such as Lord Kelvin assumed—that is, that the conductivity and specific heat may be inferred from the qualities of the surface materials—we have remained in thermal isolation from the great bulk of the interior for hundreds of millions of years, and perhaps even for more than a thousand millions of years. Assuming a diffusivity similar to that of surface rocks, and starting with a temperature of 7000° F., Kelvin found that after 1000 million years of cooling there would be no sensible change at a depth from the surface greater than 568 miles. In short, even if this great period—far beyond our estimates of geological time—has elapsed since the *consistentior status*, the cooling surface has as yet borrowed heat from only half the bulk of the earth.

It is possible, on the other hand, that the conductivity increases inwards, as Prof. Perry has contended; and if the central parts are more largely metallic, this increase may be considerable. But we find ourselves here in the regions of the unknown.

With this limitation to our knowledge, the province of geothermal speculation is a somewhat disheartening one. Thus if with Rutherford, who first gave us a quantitative estimate of the kind, we say that such and such a quantity of radium per gram of the earth's mass would serve to account for the $2{\cdot}6\times10^{20}$ calories which, according to the surface gradients, the earth is losing per annum, we cannot be taken as advancing a theory of radio-active heating, but only a significant quantitative estimate. For, in fact, the heat emitted by radium in the interior may never have reached the surface since the convective conditions came to an end.

And here, depending upon the physical limitations to our knowledge of the earth's interior, a possibility has to be faced. That uranium is entirely absent from the interior is, as I have said, in the highest degree unlikely. If it is present, then the central parts of the earth are rising in temperature. This view, that the central interior is rising in temperature, is difficult to dispose of, although we can adduce the evidence of certain surface-phenomena to show that the rise in temperature during geological time must be small or its effects in some manner kept under control. In a word, whether we assume that the whole heat-loss of the earth is now being made good by radio-active heating or not, we find, on any probable value of the conductivity, a central core almost protected from loss by the immense mass of heated material interposed between it and the surface, and within this core very probably a continuous source of heat. It is hard to set aside any of the premisses of this argument.[1]

We naturally ask, Whither does the conclusion lead us? We can take comfort in a possible innocuous outcome. The uranium itself, however slowly its energy is given up, is not everlasting. The decay of the parent substance is continually reducing the amount of heat which each year may be added to the earth's central materials. And the result may be that the accumulated heat will ultimately pass out at the surface by conductivity, during remote future times, and no physical disturbance result.

The second limitation to our hypotheses arises from this transformation and gradual disappearance of the uranium. And this limitation seems as destructive of definite geothermal theories as the first. To understand its significance requires a little consideration. The fraction of uranium decaying each year is vanishingly small, about the ten thousand-millionth part; but if the temperature of the earth is maintained by uranium, and consequently its decay involves the fall in temperature of the whole earth, the quantity of heat escaping at the surface attendant on the minute decrement would be enormous. An analogy may help to make this clear. Consider the familiar case of a boiler maintained at a particular temperature by a furnace within. Let the combustion diminish and the furnace temperature fall a little. The whole mass of the boiler and its contents follow the downward movement of temperature, heat of capacity escaping at the surface. An observer, only noting the outflow of radiated heat and unable to observe the minute drop of temperature, would probably ascribe to the continued action of the furnace heat which, although derived from it in the past, should no longer be regarded as indicating the heating value of the combustion. Magnify the boiler to terrestrial dimensions: the minutest fall in temperature of the entire mass involves immense quantities of heat passing out at the surface, which no longer indicate the sustaining radio-thermal actions within.

It is easy to see the nature of the difficulties in which we thus become involved. In fact, the heat escaping from the earth is not a measure of the radium in the earth, but necessarily includes, and for a great part may possibly be referred to, the falling temperature, which the decay of the uranium involves. If we take $\lambda$ (the fraction of uranium transforming each year) as approximately $10^{-10}$ and assume for the general mass of the earth a temperature of 1500°, a specific heat of 0·2, and, taking $6\times10^{27}$ as its mass in grams, we have, on multiplying these values together, a loss in calories per annum of $1{\cdot}8\times10^{20}$. This by hypothesis escapes at the surface. But the surface loss, as based on earth-gradients of temperature, is but $2{\cdot}6\times10^{20}$ calories. We are left with $0{\cdot}8\times10^{20}$ calories as a measure of the radium present. On this allowance our theories, in whatever form, must be shaped. Nor does it appear as if relief from this restriction can be obtained in any other way than by denying to the interior parts of the earth the requisite high thermal conductivity. Taking refuge in this, we are, however, at once confronted with the possibility of internal stores of radium of which we know nothing, save that they cannot, probably, be very great in amount. In short, I believe it will be admitted on full examination of this question that, while we very probably are isolated thermally from a considerable part of the earth's interior, the decay of the uranium must introduce a large subtractive correction upon our estimates of the limiting amounts of radium which might be present in the earth.

But, finally, is there in all these difficulties sufficient to lead us to reject the view that the present loss of earth-heat may be nearly or quite supplied by radium, and the future cooling of the earth controlled mainly by decay of the uranium? I do not think there are any good grounds for rejecting this view. Observe, it is the condition towards which every planetary body and every solar body containing stores of uranium must tend; and apparently must attain when the rate of loss of initial stores of heat, diminishing as the body grows colder, finally arrives at equilibrium with the radio-thermal supplies. This final state appears inevitable in every case unless the radio-active materials are so subordinate that they entirely perish before the original store of heat is exhausted.

Now, judging from the surface richness in radium of the earth and the present loss of terrestrial heat, it does not seem reasonable to assign a subordinate influence to radio-thermal actions; and it appears not improbable that the earth has attained, or nearly attained, this final stage of cooling.

How, then, may we suppose the existing thermal state maintained? A uniformly radio-active surface layer possessing a basal temperature in accordance with the requirements of geology is, I believe, not realisable on any probable estimate of the allowable radium, or on any concentration of it which my own experiments on igneous rocks would justify.

But we may take refuge in a less definite statement,

[1] Prof. H. A. Wilson has made a suggestive estimate of the thermal effects of radium enclosed in the central parts of the earth (NATURE, February 20, 1908).

and assume a distribution by means of which the existing thermal state of the crust may be maintained. A specially rich surface layer we must recognise, but this need be no more than a very few miles deep; after which the balance of the radium may be supposed distributed to any depth with which we are thermally connected. Below that our knowledge is indefinite. The heat outflow at the surface is in part from the surface radium, in part due to the cooling arising from the diminishing amount of uranium, in part from the deep-seated radium. In this manner the isogeotherms are kept in their places, and a state is maintained which is in equilibrium with the thermal factors involved, but which cannot be considered steady, using the word in a strictly accurate sense, in view of the decay of the uranium.

While the existing thermal state may, I think, thus be maintained by radio-active heating and radio-active decay, we find ourselves in considerable difficulties if we extend this view into the past and assume that the same could be said of any previous stage of the earth's history. If the heat emitted by the earth, when the surface was at melting temperature, was in a state of equilibrium with the radio-active supplies, then, at that date, there must have been many thousands of times the present amount of uranium on the earth, and the period of the *consistentior status* must be put back by thousands of millions of years. Apart from hopeless contradiction with every geological indication as to the age of the earth, difficulties in solar physics arise. For the sun must be supposed of equal duration, and we are required to assume impossible amounts of uranium to maintain his heat all that great lapse of time; and again this uranium would perish at just the same rate as that upon the earth, so that at the present time the solar mass must be, for by far the greater part, composed of inert materials of high atomic weight: the products of the transformations of the uranium family. The difficulty is best appreciated when we consider that even to maintain his present rate of heat-loss by radium supplies, some 60 per cent. of his mass must be composed of uranium. But there are other troubles to face if we adopt this view. The earth, or rather those parts of it which are sufficiently near the surface to lose heat at the requisite rate, would have cooled but one per cent. in $10^8$ years. Shrinkage of the outer parts and crustal thickness will be proportionately small, and we must put back our epochs of mountain building to suit so slow a rate of cooling and shrinkage and refer the earlier events of the kind to a past of inconceivable remoteness. Otherwise we must abandon the only tenable theory of mountain formation with which we are acquainted. On such a time-scale the ocean would be supersaturated under the influence of the prolonged denudation like the waters of certain salt lakes, and the sediments would have accumulated a hundredfold in thickness.

Nor do the facts as we know them require from us such sacrifices. We are not asked to raise these difficulties on supposititious quantities of uranium for the existence of which there is no evidence. Radium has occasioned no questioning of the older view that the cooling of the earth from a *consistentior status* has been mainly controlled by radiation. But, on the contrary, this new revelation of science has come to smooth over what difficulties attended the reconciliation of physical and geological evidence on the Kelvin hypothesis. It shows us how the advent of the present thermal state might be delayed and geological time lengthened, so that Kelvin's forty or fifty million years might be reconciled with the hundred million years which some of us hold to be the reading of the records of denudation.

On this more pacific view of the mission of radium to geology, what has been the history of the earth? In the earlier days of the earth's cooling the radiation loss was far in excess of the radio-thermal heating. From this state by a continual convergence, the rate of radiation loss diminishing while the radio-thermal output remained comparatively constant, the existing distribution of temperature near the surface has been attained when the radio-thermal supply may nearly or quite balance the loss by radiation. The question of the possibility of final and perfect equilibrium between the two seems to involve the interior conductivity and in this way to evade analysis.

It will be asked if the facts of mountain building and earth-shrinkage are rendered less reconcilable by this interference of uranium in the earth's physical history. I believe the answer will be in the negative. True, the greatest development of crustal wrinkling must have occurred in earlier times. This must be so, in some degree, on any hypothesis. The total shrinkage is, however, not the less because delayed by radio-thermal actions, and it is not hard to point to factors which will attend the more recent upraising of mountain chains tending to make them excel in magnitude those arising from the stresses in an earlier and thinner crust.

### *Underground Temperature.*

It would be a matter of the highest interest if we could definitely connect the rise of temperature which is observed in deep borings and tunnels with the radio-activity of the rocks. We are confronted, however, by the difficulty that our deepest borings and tunnels are still too near the surface to enable us to pronounce with certainty on the influence of the radium met with in the rocks. This will be understood when it is remembered that a merely local increase of radio-activity must have but little effect upon the temperature unless the increase be of a very high order indeed. A clear understanding of this point shows us at once how improbable it is that volcanic temperatures can be brought within a very few miles of the surface by local radio-activity of the rocks. To account on such principles for an elevation of temperature of, say, 1200° at a depth of three or four miles from the surface, a richness in radium must be assumed far transcending anything yet met with in considerable rock masses; and as volcanic materials appear to show nothing of such exceptional richness in radium we can hardly suppose local radio-activity of the upper crust responsible for volcanic phenomena.

When we come to apply calculation to results on the radio-activity of the materials penetrated by tunnels and borings, we at once find that we require to know the extension downwards of the rocks we are dealing with before we can be sure that radium will account for the thermal phenomena observed. At any level between the surface and the base of a layer of radio-active materials—suppose the level considered is that of a tunnel—the temperature depends, so far as it is due to local radium, on the total depth of the rock-mass having the observed radio-activity. This is evident. It will be found that for ordinary values of the radium content it is requisite to suppose the rocks extending downwards some few kilometres in order to account for a few degrees in temperature at the level under observation. There is, of course, every probability of such a downward extension. Thus in the case of the Simplon massif the downward continuance of the gneissic rocks to some few kilometres evokes no difficulties. The same may be said of the granite of the Finsteraarhorn massif and the gneisses of the St. Gothard massif, materials both of which are penetrated by the St. Gothard tunnel, and which appear to possess a considerable difference in radio-activity. In dealing with this subject, comparison of the results obtained at one locality with those obtained at another is the safest procedure. We must accordingly wait for an increased number of results before much can be inferred. I will now lay the cases of the two great tunnels as briefly as possible before you.

And first as to the temperature effects observed in the two cases.

The Simplon tunnel for a length of some seven or eight kilometres lies at a mean distance of about 1700 metres from the surface. At the northerly end of this stretch the rock temperature attains 55°, and at the southern extremity has fallen to about 35°. The temperature of 55° is the highest encountered. The maximum predicted by Stapff, basing his estimates on his experience of the St. Gothard tunnel, was 47°. Other authorities in every case predicted considerably lower temperatures. Stockalper, who also had experience of the St. Gothard, predicted 36° at a depth of 2050 metres from the surface, and Heim 38° to 39°.[1]

[1] See the account given by Schardt, *Verhandl. Schweizerischen Naturf. Gesellsch.*, 1904, lxxxvii., "Jahresversammlung," p. 204 *et seq.*

When the unexpectedly high temperatures were met with, various reasons were assigned. Mr. Fox has suggested volcanic heat. Others point to the arrangement of the schistosity and the dryness of the rocks, where the highest temperatures were read. The latter is evidently to be regarded more as explanation of the lower temperatures at the south end of the tunnel, where the water circulation was considerable, than of the high temperatures of the northern end. The schistosity may have some influence in bringing the isogeotherms nearer to the surface; however, not only are the rocks intensely compact in every direction, but what schistosity there is by no means inclines in the best directions for retention of heat. From the sections the schistosity appears generally to point upwards at a steep angle with the tunnel axis.[1]

Where there is such variability in the temperatures, irrespective of the depth of overlying rock, there is difficulty in assigning any significant mean gradient. The highest readings are obviously those least affected by the remarkable water-circulation of the Italian side. The higher temperatures afford such gradients as would be met in borings made on the level—about 31 metres per degree.

The temperatures read in the St. Gothard rocks were of a most remarkable character. For the central parts of the tunnel the gradients come out as 46·6 metres per degree. Stapff, who made these observations and conducted the geological investigations, took particular pains to ascertain the true surface temperatures of the rock above the tunnel; and from these ascertained temperatures, the temperatures in the tunnel rock and the overlying height of mountain, he calculated the gradients.

But this low gradient is by no means the mean gradient. At the north end, where the tunnel passes through the granite of the Finsteraarhorn massif, there is a rise in the temperature of the rock sufficient to steepen the gradient to 20·9 metres per degree. Stapff regarded this local rise of temperature as unaccountable save on the view that the granite retained part of the original heat. This matter I will presently return to.

Now, it is a fact that the radium-content of the Simplon rocks, after some allowance for what I have referred to as sporadic radium, stands higher than is afforded by the rocks in the central section of the St. Gothard, where the gradient is low. For the Simplon the general mean is (on my experiments) 7·1 billionths of a gram per gram. This mean is well distributed as follows:—

| | |
|---|---|
| Jurassic and Triassic altered sediments ... ... ... | 6·4 |
| Crystalline schists, partly Jurassic and Triassic, partly Archæan ... ... ... ... ... ... ... ... ... | 7·3 |
| Monte Leone gneiss and primitive gneiss ... ... ... | 6·3 |
| Schistose gneiss (a fold from beneath)... ... ... ... | 6·5 |
| Antigorio gneiss ... ... ... ... ... ... ... ... ... | 6·8 |

The divisional arrangement is Prof. Schardt's. Forty-nine typical rocks are used in obtaining these results, and the experiments have been in many cases repeated on duplicate specimens. Including some very exceptional results, the mean would rise to $9 \cdot 1 \times 10^{-12}$ grams per gram.

Of the St. Gothard rocks I have examined fifty-one specimens selected to be, as far as attainable, representative.[2]

Of these, twenty-one are from the central region, and their mean radium content is just 3·3. The portion of the tunnel from which these rocks come is closely coincident with Stapff's thermal subdivision of regions of low temperature.[3] This portion of the mountain offers the most definite conditions for comparison with the Simplon results. The region south of this is affected by water circulation; the regions to the north are affected by the high temperature of the granite.

We see, then, that the most definite data at our disposal in comparing the conditions as regards temperature and radio-thermal actions in the two tunnels appear to show that the steeper gradient is associated with the greater radium-content.

It is possible to arrive at an estimate of the downward extension of the two rock masses (assumed to maintain to the same depth their observed radio-activity), which would account for the difference in gradient. In making this estimate, we do not assume that the entire heat-flow indicated by the gradients is due to radium, but that the difference in radium-content is responsible for the difference of heat-flow. If some of the heat is conducted from an interior source (of whatever origin), we assume that this is alike in both cases. We also assume the conductivities alike.

Calculating on this basis, the depth required to establish on the radium measurements the observed difference in gradients of the Central St. Gothard and of the Simplon, we find the depth to be about 7 kilometres on the low mean of the Simplon rocks, and 5 kilometres on the high mean. There is, as I have already said, nothing improbable in such a downward extension of primitive rocks having the radio-activities observed; but as a different distribution of radium may, of course, obtain below our point of observation, the result can only claim to be suggestive.

Turning specially to the St. Gothard, we find that a temperature problem of much interest arises from the facts recorded. The north end of the tunnel for a distance of 2 kilometres traverses the granite of the Finsteraarhorn massif. It then enters the infolded syncline of the Usernmulde and traverses altered sediments of Trias-Jura age for a distance of about 2 kilometres. After this it enters the crushed and metamorphosed rocks of the St. Gothard massif, and remains in these rocks for $7\frac{1}{2}$ kilometres. The last section is run through the Tessinmulde for 3 kilometres. These rocks are highly altered Mesozoic sediments.

I have already quoted Stapff's observations as to the variations of gradient in the northern, central, and southern parts of the tunnel. He writes: "They (the isotherms) show irregularities on the south side, which clearly depend on cold springs, they bend down rapidly, and then run smoothly inclined beneath the water-filled section of the mountain. Other local irregularities can be explained by the decomposition of the rock; but there is no obvious explanation of the rapid increase in the granite rocks at the northern end of the tunnel (200n metres), and it is probably to be attributed to the influence of different thermal qualities of the rock on the coefficient of increase. For the rest these 2000 metres of granite belong to the massif of the Finsteraarhorn, and, geologically speaking, they do not share in the composition of the St. Gothard. Perhaps these two massifs belong to different geological periods (as supposed for geological reasons long ago). What wonder, then, if one of them be cooler than the other." (*Loc. cit.*, p. 30.)

Commenting on the explanation here offered by Stapff, Prestwich[1] states his preference for the view that the excess of temperature in the granite is due to mechanical actions to which the granite was exposed during the upheaval of this region of the Alps.

The accompanying diagram shows the distribution of temperature as given by Stapff, and the distribution of radium as found from typical specimens of the rocks. There is a correspondence between the two which is obvious, and when it is remembered that the increase in radio-activity shown at the south end would have been, according to Stapff, masked by water circulation, the correspondence becomes the more striking. The small radium values in the central parts of the tunnel are remarkable. The rocks of the Central St. Gothard massif are apparently exceptionally poor in radium.

At the north end the excess of radium is almost confined to the granite, the rock to which Stapff ascribed the exceptional temperatures. The radium of the Usernmulde is probably not very important, seeing that these sediments cannot extend far downwards. The principal local source of heat appears located more especially beneath the synclinal fold, for Stapff's table (*loc. cit.*, p. 31) of the gradients beneath the plain of Andermatt shows a rising gradient to a point about 2500 metres

[1] Schardt, *loc. cit.*

[2] I would like to express here my acknowledgments to the Trustees of the British Museum for granting me permission to use chips of the rocks in their possession; and especially to Mr. Prior for his valuable assistance in selecting the specimens.

[3] Trans. North of England Mining and Mec. Engineers, xxxiii., p. 25.

[1] Proc. R.S., xli., p. 44.

from the north entrance of the tunnel. It is observable that the radio-activity of the granite increases as it approaches the Usernmulde and attains its maximum (14·1) where it dips beneath the syncline.

The means of radium-content in the several geological sections into which the course of the tunnel is divisible are as follows:—

| | |
|---|---|
| Granite of Finsteraarhorn ... ... . ... ... | 7·7 |
| Usernmulde ... ... ... ... ... ... ... ... ... | 4·9 |
| St. Gothard massif ... ... ... ... ... ... ... ... | 3·9 |
| Tessinmulde .. ... ... ... ... ... ... ... ... | 3·4 |

The central section, however, if considered without reference to geological demarcations, would, as already observed, come out as barely 3·3. And this is the value of the radio-activity most nearly applicable to Stapff's thermal subdivision of the region of low temperature.

If we accept the higher readings obtained in the granite as indicative of the radio-active state of this rock beneath the Usernmulde, a satisfactory explanation of the difference of heat-flow from the central and northern parts of the tunnel is obtained. Using the difference of gradient as basis of calculation, as before, we find that a downward extension of about six thousand metres would, if the outflow took place in an approximately vertical direction, account for the facts observed by Stapff. This depth is in agreement with the result as to the downward extension of the St. Gothard rocks as derived from the comparison with the Simplon rocks.


We are by no means in a position to found dogmatic conclusions on such results; they can only be regarded as encouragement to pursue the matter further. The coincidence must be remarkable which thus similarly localises radium and temperature in roughly proportional amounts, and permits us, without undue assumptions, to explain such remarkable differences of gradient. There is much work to be done in this direction, for well-known cases exist where exceptional gradients in deep borings have been encountered—exceptional both as regards excess and deficiency.

*Radio-active Deposits and the Instability of the Crust.*

At the meeting of the British Association held last year at Leicester, I read a note on the thermal effects which might be expected to arise at the base of a sedimentary accumulation of great thickness due to the contained radium.

The history of mountain building has repeated itself many times: ages of sedimentation, with attendant sinking of the crust in the area of deposition, then upheaval, folding up of the great beds of sediment, and even their over-thrusting for many miles. So that the mountain ranges of the world are not constituted from materials rising from below, save in so far as these may form a sustaining core, but of the slowly accumulating deposits of the ages preceding the upheaval.

The thickness of collected sediments involved in these great events is enormous, and although uncertainty often attends the estimation of the aggregate depths of sedimentation, yet when we consider that unconformities between the deposits of succeeding eras represent the removal of vast masses of sediment to fresh areas of deposition, and often in such a way as to lead to an underestimate of the thickness of deposit, the observations of the geologist may well indicate the minor and not the major limit. Witness the mighty layers of the Huronian, Animikean, and Keweenawan ages where deposits measured in miles of thickness are succeeded by unrecorded intervals of time, in which we know with certainty that the tireless forces of denudation laboured to undo their former work. Each era represents a slow and measured pulse in the earth's crust, as if the overloading and sinking of the surface materials induced the very conditions required for their re-elevation. Such events, even in times when the crust was thinner and more readily disturbed than it is now, must have taken vast periods of time. The unconformity may represent as long a period as that of accumulation. In these Proterozoic areas of America, as elsewhere on the globe and throughout the whole of geological history, there has been a succession in time of foldings of the crust always so located as to uplift the areas of sedimentation, these upheavals being sundered by long intervals during which the site of sedimentation was transferred and preparation made for another era of disturbance. However long deferred there seems to be only the one and inevitable ending, inducing a rhythmic and monotonous repetition surely indicative of some cause of instability attending the events of deposition.

The facts have been impressively stated by Dana: "A mountain range of the common type, like that to which the Appalachians belong, is made out of the sedimentary formations of a long preceding era; beds that were laid down conformably, and in succession, until they had reached the needed thickness; beds spreading over a region tens of thousands of square miles in area. The region over which sedimentary formations were in progress in order to make, finally, the Appalachian range, reached from New York to Alabama, and had a breadth of 100 to 200 miles, and the pile of horizontal beds along the middle was 40,000 feet in depth. The pile for the Wahsatch Mountains was 60,000 feet thick, according to King. The beds for the Appalachians were not laid down in a deep ocean, but in shallow waters, where a gradual subsidence was in progress; and they at last, when ready for the genesis, lay in a trough 40,000 feet deep, filling the trough to the brim. It thus appears that epochs of mountain making have occurred only after long intervals of quiet in the history of a continent."

The generally observed fact that the deposition of sediments in some manner involves their ultimate upheaval has at various times led to explanations being offered. I think I am safe in saying that although the primary factor, the compressive stress in a crust which has ceased to fit the shrinking world within it, has probably been correctly inferred, no satisfactory explanation of the connection between sedimentation and upheaval has been advanced. The mere shifting upwards of the isogeotherms into the deposits, advanced as a source of local loss of rigidity by Babbage and Herschel, need not involve any such loss so long as the original distance of the isogeotherms from the surface is preserved.

We see in every case that only after great thicknesses of sediments have accumulated is the upheaval brought about. This is a feature which must enter as an essential condition into whatever explanation we propose to offer.

Following up the idea that the sought-for instability is referable to radio-thermal actions, we will now endeavour to form some approximate estimate of the rise of temperature which will be brought about at the base of such great sedimentary accumulations as have gone towards mountain building, due to the radium distributed throughout the materials.

The temperature at the base of a feebly radio-active layer, such as an accumulation of sediments, is defined in part by radio-active energy, in part by its position relative to the normal isogeotherms, whether these latter are in turn due to or influenced by radio-thermal supplies or not. It is convenient, and I think allowable, to consider these two effects separately, and deal with them as if they were independent, the resultant state being obtained by their summation.

In dealing with the rise of temperature at the base of a radio-active layer we arrive at an expression which involves the square of the depth. This is a very important feature in the investigation, and leads to the result that, for a given amount of radium, diffuse distribution through a great depth of deposit gives rise to a higher basal temperature than a more concentrated distribution in a shallower layer.

But this will not give us the whole effect of such a deposit. Another and an important factor has to be taken into account. We have seen that the immediate surface rocks are of such richness in radium as to preclude the idea that a similar richness can extend many miles inward.

Now, it is upon this surface layer that the sediments are piled, and as they grow in thickness this original layer is depressed deeper and deeper, yielding under the load until at length it is buried to the full depth of the overlying deposit. This slow and measured process is attended by remarkable thermal effects. The law of the increase of temperature with the square of the depth comes in, and we have to consider the temperature effect not merely at the base of the deposited layer, but that due to the depression and covering over of the radium-rich materials upon which the sediments were laid down.

The table which follows embodies an approximate statement of the thermal results of various depths of deposit supposed to collect under conditions of crustal temperature such as prevail in this present epoch of geological history:—

| Thickness of sedimentary deposit | | Resulting rise of isogeotherms | | Weakening of earth's crust as defined by the rise of the geotherm at 40 kilometres |
|---|---|---|---|---|
| Kilometres | | Kilometres | | Kilometres |
| 6 | ... | 7·4 | ... | 40 to 32·6 |
| 8 | ... | 10·2 | ... | 40 to 29·8 |
| 10 | ... | 13·3 | ... | 40 to 26·7 |
| 12 | ... | 16·7 | ... | 40 to 23·3 |
| 14 | ... | 20·4 | ... | 40 to 19·6 |

I have deferred to the conclusion of this address an account of the steps followed in obtaining the above results. It is clearly impossible, within the limited time allotted to me, to make these quite clear. It must suffice here merely to explain the significance of the figures.

The first column gives the depth of sedimentary deposit supposed to be laid down on the normal radio-active upper crust of a certain assumed thickness and radio-activity. From the rise of temperature which occurs at the base of this crust (due to the radio-activity, not only of the crust, but of the sediments) the results of the second column are deduced, the gradient or slope of temperature prevailing beneath being derived from the existing surface gradients corrected for the effects of the radio-thermal layer. The third column is intended to exhibit the effect of this shift of the geotherms in reducing the strength of the crust. I assume that at a temperature of 800° the deep-seated materials lose rigidity under long-continued stress. The estimated depth of this geotherm is, on the assumptions, about 40 kilometres. The upward shift of this geotherm shows the loss of strength. Thus in the case of a sedimentary accumulation of 10 kilometres the geotherm defining the base of the rigid crust shifts upwards by 13 kilometres, so that there is a loss of effective section to the amount of 30 per cent.[1]

As regards the claims which such figures have upon our consideration, my assumptions as to thickness and radio-activity of the specially rich surface layer are, doubtless, capable of considerable amendment. It will be found, however, that the assumed factors may be supposed to vary considerably, and yet the final results prove such as, I believe, cannot be ignored. Indeed, those who are in the way of making such calculations, and who enter into the question, will find that my assumptions are not specially favourable, but are, in fact, made on quite independent grounds. Again, a certain class of effects has been entirely left out of account, effects which will go towards enhancing, and in some cases greatly enhancing, the radio-thermal activity. I refer to the thickening of the crust arising from tangential pressure, and, at a later stage, the piling up and overthrusting of mountain building materials. In such cases the temperature of the deeper parts of the thickened mass must still further rise under the influence of the contained radium. These effects only take place, indeed, after yielding has commenced, but they add to the element of instability which the presence of the accumulated radio-active deposits occasions, and doubtless increase thermal metamorphic actions in the deeper sediments, and result in the refusion of rocks in the upper part of the crust.[2]

The effect of accumulated sediment is thus necessarily a reduction in the thickness of that part of the upper crust which is capable of resisting a compressive stress. Over the area of sedimentation, and more especially along the deepest line of synclinal depression, the crust of the globe for a period assumes the properties belonging to an earlier age, yielding up some of the rigidity which was the slow inheritance of secular cooling. Along this area of weakness—from its mode of formation generally much elongated in form—the stressed crust for many hundreds, perhaps thousands, of miles finds relief, and flexure takes place in the only possible direction; that is, on the whole upwards. In this way the prolonged anticline bearing upwards on its crest the whole mass of deposits is formed, and so are born the mountain ranges in all their diversity of form and structure.

We have in these effects an intervention of radium in the dynamics of the earth's crust, which must have influenced the entire history of our globe, and which, I believe, affords a key to the instability of the crust. For after the events of mountain building are accomplished, stability is not attained, but in presence of the forces of denudation the whole sequence of events has to commence over again. Every fresh accession of snow to the firn, every passing cloud contributing its small addition to the

[1] See Appendix B.

[2] Prof. C. Schmidt (Basel) has recently given reasons for the view that the Mesozoic schists of the Simplon at the period of their folding were probably from 15,000 to 20,000 metres beneath the surface ("Ec. Geol. Helvetiæ," vol. ix., No. 4, p. 590). As another instance consider the compression of the Laramide range (Dawson, Bull. Geol. Soc. Am., xii., p. 87).

torrent, assists to spread out once more on the floor of the ocean the heat-producing substance. With this rhythmic succession of events appear bound up those positive or negative movements of the strand which cover and uncover the continents, and have swayed the entire course of evolution of terrestrial life.

*Oceanic Deposits.*—The displacements of the crust which we have been considering are now known to be by no means confined to the oceanic margins. The evidence seems conclusive that long-continued movements have been in progress over certain areas of the sea floor, attended with the formation of those numerous volcanic cones upon which the coral island finds foundation. Here there are plainly revealed signs of instability and yielding of the crust (although, perhaps, of minor intensity) such as are associated with the greater movements which terminate in mountain building. I think it will be found, when the facts are considered, that we have here phenomena continuous with those already dealt with, and although the conditional element of a sufficient sedimentary accumulation must remain speculative, the evidence we possess is in favour of its existence.

One of the most interesting outstanding problems of deep-sea physiography is that of the rates of accumulation of the several sorts of deposit. In the case of the more rapidly collecting sediments there seems no serious reason why the matter should not be dealt with observationally. I hope it may be accomplished in our time. For my present purpose I should like to know what may or may not be assumed in discussing the accumulation of radio-active sediments on the ocean floor.

As regards the rate of collection of the non-calcareous deposits, the nearest approach to an estimate is, I think, to be obtained from the exposed oceanic deposits of Barbados. In the well-known paper of Jukes Brown and Harrison[1] on the geology of that island, it is shown that the siliceous radiolarian earths and red clays aggregate to a thickness of about 300 feet. These materials are true oceanic deposits, devoid of terrigenous substances. They collected very probably during Pliocene and, perhaps, part of Pleistocene times. Now, there is evidence to lead us to date the beginning of the Pliocene as anything from one million to three million years ago. The mean of these estimates gives a rate of collection of 5 millimetres in a century. This sounds a very slow rate of growth, but it is too fast to be assumed for such deposits generally. More recent observations might, indeed, lead us to lengthen the period assigned to the deposition of these oceanic beds; for if, following Prof. Spencer,[2] we ascribe their deposition to Eocene times, a less definite time-interval is indicated; but the rate could hardly have been less than 3 millimetres in a century. The site of the deposit was probably favourable to rapid growth.

We have already found a maximum limit to the average thickness of true oceanic sediments; and such as would obtain over the ocean floor if the rate of collection was everywhere the same and had so continued during the past. If there is one thing certain, however, it is that the rates of accumulation vary enormously. The 1200 or 1500 feet of chalk in the British Cretaceous, collected in one relatively brief period of submergence, would alone establish this. Huxley inferred that the chalk collected at the rate of 1 inch in a year. Sollas showed that the rate was more probably 1 inch in forty years. Sir John Murray has advanced evidence that in parts of the Atlantic the cables become covered with Globigerina ooze at the rate of about 10 inches in a century. Finally, then, we must take it that the fair allowance of one-seventh of a mile may be withheld in some areas and many times exceeded in others.

Now it is remarkable that all the conditions for rapid deposition seem to prevail over those volcanic areas of the Pacific from which ascend to the surface the coral islands —abundant pelagic life and comparatively shallow depths. Indeed, I may remind you that the very favourable nature of the conditions enter into the well-known theory of coral island formation put forward by Murray.

The islands arise from depths of between 1000 and 2000 fathoms. These areas are covered with Globigerina ooze having a radio-activity of about 7 or 8. The deeper-lying deposits around—red clay and radiolarian ooze—show radio-activities up to and more than 50. From these no volcanic islands spring.

These facts, however, so far from being opposed to the view that the radio-activity and crustal disturbance are connected, are in its favour. For while those rich areas testify to the supply of radio-active materials, the slow rate of growth prevailing deprives those deposits of that characteristic *depth* which, if I may put it so, is of more consequence than a high radio-activity. For the rise in temperature at the base of a deposit, as already pointed out, is proportional to the square of the thickness; in reality the dilution of the supplies of uranium which reach the calcareous oozes flooring the disturbed areas is a necessary condition for any effective radio-thermal actions.

It might appear futile to consider the matter any closer where so little is known. But in order to give an idea of the quantities involved I may state that, if my calculations are correct, a rate of deposit comparable with that of the chalk prevailing for ten million years would, on assumptions similar to those already explained when discussing the subject of mountain building, occasion a rise of the deeper isogeotherms by from 20 to 30 per cent. of their probable normal depth.

In making these deductions as to the influence of radium in sedimentary deposits, I have so far left out of consideration the question of the time which must elapse in order that the final temperature-rise in the sediments must be attained. The question we have to answer is: Will the rate of rise of temperature due to radium keep pace with the rate of deposition, or must a certain period elapse after the sedimentation is completed to any particular depth, before the basal temperature proper to the depth is attained?

The answer appears to be, on an approximate method of solution, that for rates of deposition such as we believe to prevail in terrigenous deposits—even so great as 1 foot in a century, and up to depths of accumulation of 10 kilometres and even more—the heating waits on the sedimentation. Or, in other words, there is thermal equilibrium at every stage of growth of the deposit; and the basal temperature due to radio-active heating may at any instant be computed by the conductivity equation. For accumulations of still greater magnitude the final and maximum temperature appears to lag somewhat behind the rate of deposition.

From this we may infer that the great events of geological history have primarily waited upon the rates of denudation and sedimentation. The sites of the terrigenous deposits and the marginal oceanic precipitates have many times been convulsed during geological time because the rates of accumulation thereon have been rapid. The comparative tranquillity of the ocean floor far removed from the land may be referred to the absence of the inciting cause of disturbance. If, however, favourable conditions prevail for such a period that the local accumulations attain the sufficient depth, here, too, the stability must break down and the permanency be interrupted.

Upheaval of the ocean floor, owing to the laws of deep-sea sedimentation, should be attended with effects accelerative of deposition—a fact which may not be without influence. But although ultimately sharing the instability of the continental margins, the cycle of change is tuned to a slower periodicity. From the operation of these causes, possibly, have come and gone those continents which many believe to have once replaced the wastes of the oceans, and which with all their wealth of life and scenic beauty have disappeared so completely that they scarce have left a wreck behind. But those forgotten worlds may be again restored. The rolled-up crust of the earth is still rich in energy borrowed from earlier times, and the slow but mighty influences of denudation and deposition are for ever at work. And so, perchance, in some remote age the vanished Gondwána Land, the lost Atlantis, may once again arise, the seeds of resurrection even now being sown upon their graves from the endless harvests of pelagic life.

[1] Q.J.G.S., xlviii., p. 210.

[2] *Ibid.*, lviii., p. 354 *et seq.*

### APPENDIX A.

*Convective Movement of Uranium to the Earth's Surface.*—The estimate of temperature given assumes (1) that the mass of igneous material is spherical, and (2) that its surface is kept at constant temperature, heat escaping freely. The first assumption is in favour of increasing the estimate of temperature, and probably would not generally be true, especially of a mass moving upwards. The second assumption tends to give a lower estimate of temperature, and is certainly misleading, as the surrounding materials are non-conducting, and must favour the accumulation of radio-active heat.

On assumptions (1) and (2) and on Barus' results for the thermal expansion of diabase between 1100° and 1500°,[1] and results of my own on basalt,[2] which are in approximate agreement, and assuming the mean excess of temperature to be 500° and the surrounding material to be at a fluid temperature, the force of buoyancy comes out at more than 60 dynes per cubic centimetre of the spherical mass. This is an under-estimate.

If we may assume that the Deccan Trap is indeed an instance of such an over-heated mass escaping at the surface, and that similar radio-active masses rising up from beneath at various times in the past may have affected the crust, we have at our disposal a local source of energy of plutonic origin which may account for much.

### APPENDIX B.

*Sedimentation and Rise of Geotherms.*—The depth of the upper radio-active layer is, of course, unknown. We possess, however, the means of arriving at some idea of what it must be. The quantitative thermal conditions impose a major limit to its average thickness, and the indications of injected rocks suggest a minor limit.

It will be found that if $2\cdot6\times10^{20}$ calories is the heat output of the whole earth per annum, and if we assign only one-fifth of this amount to cooling due to decay of the uranium, then, on the assumption that the earth is no longer losing any part of its original store of heat, we have about $2\times10^{20}$ representing radium heating. From this the allowance of terrestrial radium per square centimetre inwards is $2\cdot3\times10^{-5}$ grams. This would give a major limit. But it is almost certain that some of this radium is located in more deeply seated parts of the earth. If we take $10^{-5}$ as contained in the normal radio-active surface layer, and assume (what according to my experiments should not be far from the truth) that the average radio-activity is 3, we arrive at a thickness of 12 kilometres.

Some such mean value is necessitated by the evidence we derive from the radio-activity of igneous rocks. These rocks must in many cases be derived from considerable depths. Such outflows as the Deccan may indicate local sub-crustal conditions; so also may the eruptions of certain volcanic areas. But those extrusions which have attended mountain building, more especially its closing phases, appear to indicate general conditions, and involve the existence of such radio-active materials at considerable depths. If we assume a thickness for the radio-active part of the crust much less than the 12 kilometres, difficulties are met with on this line of reasoning.[3]

Proceeding now to the derivation of the results given in the table, p. 464. The equation $k\theta=qhx(D-x/2)$ (where $\theta$ is the temperature at the depth $x$, D being the total depth of the radio-active layer, $q$ the radium per c.c. in grams, $h$ the heat output of one gram of radium per second, $k$ the thermal conductivity) is easily derived by considering the conditions of thermal flow in the layer, supposed to lose heat only at the surface.[4]

The aggregate depths of radio-active material in the several cases of sedimentary deposit assumed in my address amount to 18, 20, 22, 24, and 26 kilometres. I assume the mean radio-activity to be 3·5, and the average conductivity to be $4\times10^{-3}$. From this the basal temperatures are found, as due to radio-thermal actions. These temperatures are to be augmented by the temperatures proper to the several depths, which depend upon the conducted interior heat. To estimate these we require to apportion the observed average surface gradient (taken as 32 metres per degree) between radio-active effects in the upper layer and the flow of heat from within. The radio-thermal gradient comes out at about 75 metres; the inner gradient is accordingly 56 metres. Hence the total temperature at the base of each radio-active mass is obtained. But the geotherms proper to the several depths, 18, 20, &c., kilometres, under conditions prevailing elsewhere in the crust, are easily found from the value of $\theta$ for the normal layer (82° C.), and adding the temperature due to interior heat. From the difference of the temperatures we, finally, find the rise of the geotherms.

As conveyed in my address, I have found on several different values of the thickness and radio-active properties of the surface layer, results in every case showing large values for the rise of the geotherms. The data assumed above are by no means the most favourable.

[1] Phil. Mag., xxxv., p. 173.

[2] Trans. R.D.S., vi., p. 208.

[3] See p. 464, *ante*, and foot-note as bearing on the possible displacement of the geotherms.

[4] See Strutt, Proc. R S., lxxvii., p 482.

## NOTES.

IT is with deep regret that we learn of the sudden death of Prof. Alexis Hansky, whose work in solar physics at the Pulkowa Observatory has attracted so much attention. According to a letter from M. Tikhoff, which appears in the September number of the *Bulletin de la Société astronomique de France*, M. Hansky was drowned whilst bathing in the Black Sea at Simeise, in the Crimea, on August 11 (July 29 O.S.). The deceased astronomer commenced his practical work in solar physics by observing the total eclipse of 1896 at Novaya Zemlya, and at the time of his tragic death was engaged in the installation of a new observatory in the Crimea which had been given to him, and which he had handed over to the Pulkowa Observatory. By his death at the early age of thirty-six years, the study of solar physics has suffered a loss which it will be exceedingly difficult to repair.

THE President of the Local Government Board has arranged for the making of the two following researches:—a chemical and bacteriological investigation, by Mr. C. G. Moor and Prof. R. T. Hewlett, as to the influence of softening and of other chemical processes on the purity of water supplies from the chalk as shown in actual experience and under experimental conditions, and an investigation by Prof. Sidney Martin, F.R.S., into the powers of production of disease possessed by certain streptococci and by the poisonous substances produced by them, in continuance of previous investigations by him on the same subject. These investigations complete the allocation of the scientific grant for the year 1908–9.

PROF. ROBERT KOCH has been chosen to represent the German Government at the forthcoming International Tuberculosis Congress at Washington.

THE annual conference of the Sanitary Inspectors' Association opened on Tuesday last under the presidency of Sir James Crichton-Browne, F.R.S.

THE third International Philosophy Congress has been in session at Heidelberg during a portion of the past week. The next meeting will take place in 1912, at Bologna.

THE arrangements for the fourth International Fisheries Congress, which, as has already been announced, is to be held at Washington from September 22–26, are now complete. An attractive itinerary has been arranged for the week following the sessions of the congress, and includes visits to New York City, Narragansett Bay, Wood's Hole, Boston, and Gloucester, at each of which places local committees and individual residents will provide demonstrations of fishery methods and incidental entertainment. The methods of oyster culture employed on the great New England beds, the pound-net fishery, the purse-seine fishery, inspection of fish markets and vessels, the methods of deep-sea research, and other matters relating to the fisheries will be shown. Special itineraries will be arranged for members who may desire to visit other fisheries and hatcheries, and letters of introduction will be furnished.

An International Rubber Exhibition (lasting a fortnight) is to be held at Olympia, London, from September 14. The exhibits will consist wholly of objects of interest to members of the rubber and allied trades, and will comprise illustrations of the growth of the commodity and examples of the machinery employed in its manipulation. Rubber trees in all stages of their growth will be shown, together with the raw material obtained from them, and the varied forms into which it is manufactured. Demonstrations will be given in a laboratory, and growers, manufacturers, and others will have an opportunity of discussing questions relating to the industry at an international congress, to which delegates have been sent by many Continental countries. Borneo, Mexico, and other rubber-producing countries are taking part in the enterprise.

At the third International Congress of the History of Religions, which is to be held on September 15–18 at Oxford under the presidency of Sir Alfred Lyall (Prof. E. B. Tylor, F.R.S., being honorary president), the following papers will be communicated to general meetings of the congress:—the address of the president; religious wisdom cultivated in old Israel in common with neighbouring peoples, by Prof. von Orelli; l'Influence religieuse de l'Astrologie dans le Monde Romain, by Prof. Cumont; Buddhistic religious art, by Prof. Macdonell; some ethical developments of pre-Christian Judaism, by Dr. Charles; totemism, by Dr. F. Boaz; and the Cretan religions, by Dr. Arthur Evans, F.R.S.

Among the papers to be read at the International Congress of the Refrigerating Industries (which, as has already been stated in these columns, is to take place in Paris on October 5–12 next) we notice the following:—the effects of low temperature, by Sir W. Ramsay, K.C.B., F.R.S.; liquid air, by Dr. L. A. Groth; the construction of cold stores, by Mr. Hal Williams; notes on methods and apparatus for ascertaining the heat, conductivity, and insulating properties of materials, by Mr. W. D. A. Bost; the refrigeration of, and transport of refrigerated, fruit, &c., Mr. C. M. Simons, Mr. F. W. J. Moore, and Mr. H. J. Ward; ice-making and ice-machinery, by Mr. T. F. Mead; new industrial applications of cold, by Mr. H. Birkett; the organisation of cold-storage transport on railways—refrigerator-cars, cold-storage warehouses, and charges, by Mr. T. N. Wylie; and the organisation of cold-storage transport by sea, by Mr. J. T. Milton.

A somewhat severe earthquake shock is reported to have been felt at Shemakha (Transcaucasia) at 8 o'clock in the evening of September 1. The direction was from south to north.

A monument to Hermann von Wissmann, the German African explorer, was unveiled at Lauterberg, in the Harz, on Friday last.

Mr. F. J. Seaver, assistant botanist of the North Dakota Agricultural College, has been appointed director of laboratories in the New York Botanical Garden.

Dr. K. Wegener has, according to *Science*, been appointed director of the Observatory of Samoa.

The new building of the medical college of Western Reserve University (which will be devoted to experimental medicine) is to be dedicated on November 20, when an address will be delivered by Dr. W. H. Welch, of the Johns Hopkins Medical School.

The College of Physicians, Philadelphia, has awarded the Alvarenga prize for 1908 to Dr. William T. Shoemaker, for his essay on "Retinitis Pigmentosa."

The fourth field meeting (to Bisley) of the Cotteswold Naturalists' Field Club will be held on Tuesday next, when those attending will drive from Stroud to the Frith Quarry and Worgan's Quarry to study the richly fossiliferous Inferior-Oolite strata there exposed.

Arrangements are being made for the holding of fungus forays under the auspices of the South-Eastern Union of Scientific Societies in the neighbourhood of Tunbridge Wells on October 9 and 10. Full particulars respecting the same may be obtained from the honorary secretary of the cryptogamic section, Dr. George Abbott, 4 Rusthall Park, Tunbridge Wells.

During the past week there has been much activity in France in the interests of aërial navigation. On September 5 the military dirigible balloon, the *République*, made the longest flight so far achieved by her. Leaving her headquarters at Chalais-Meudon at 8.40, she crossed Paris, and proceeded by way of Senlis and Pont St. Maxence to Compiègne, which was reached at 12.30. Circling here, without stopping she returned to Paris by a slightly more eastern route, and was back at Chalais-Meudon by 3.10. The journey, which thus lasted six hours and a half, is estimated at between 180 and 200 kilometres. The balloon attained a height of 650 metres, and of the 420 kilograms of ballast with which she started, 190 kilograms remained at the end of the journey. At Le Mans, Mr. Wilbur Wright made at 7.30 in the morning a flight of 19m. 48 2-5s., which is within a few seconds of the "world's record" of Mr. Farman, namely, 20m. 9 3-5s. The distance covered is estimated at 22 kilometres. In attempting a second flight, which lasted 3m. 21s., at a height of 12 to 15 metres, a violent gust of wind drove the aëroplane so near the trees on the edge of the ground that a sudden turn had to be made, in the accomplishment of which the end of the left wing came in contact with the earth and was broken. On September 6 M. Delagrange made a flight lasting 29m. 53 4-5s., and covered a distance of 24 kilometres 727 metres. He was compelled to alight from want of fuel, having started with only 24 litres. This flight constitutes a new "world's record," both for time and distance.

According to the *Pharmaceutical Journal*, an important step is being taken by the Commonwealth Government in regard to the adoption of uniform food standards throughout Australia. Under the present system each State fixes its own standards, the result being considerable variance, and consequent annoyance and expense to manufacturers and importers. Now that a Commonwealth analyst has been appointed, the way is cleared for federal action, and the proposal is made for a conference of Commonwealth and State expert authorities with the object of discussing the basis of united legislation.

It is stated in the *Lancet* that out of 50,000 pupils in the primary schools of Milan 47,000 are more or less the victims of buccal maladies, mainly affecting the teeth, and steps are being taken to bring about a more satisfactory condition of things. To this end the Associazione per la Scuola, composed of representatives of the family and of the teaching profession, the Istituto Stomatologico Italiano, and the municipality, are acting in concert to make a periodical inspection of the primary schools, beginning with the coming scholastic year 1908–9. This inspection is to be carried out by the "Commissione d'Igiene," presided over by Dr. Ambrogio Bertarelli, and composed of Dr. Bordoni-Uffreduzzi, Dr. Clerici, and other eminent consultants and practitioners of the Lombard school. Under the auspices of this commission the inspection will be performed by the specialists attached to the Istituto Stomatologico, who will communicate to the parents or guardians of the children concerned the stomatological condition of each, illustrated with appropriate diagrams. A small fee will be expected from the well-to-do families of the children inspected, while the service will be rendered gratuitously to those of humble means. At the end of the year statistical tables of the cures effected and of the results obtained will be presented to the municipality.

Outbreaks of American gooseberry mildew having occurred in various parts of Essex, and the matter having been brought under the notice of a committee of the Essex County Council, the county inspectors have been authorised to enter premises where the disease is believed to exist with the view of specimens being sent to the county laboratories to be reported upon.

Silver medals are this year offered by the Industrial Society of Mulhouse for the synthesis of a gum possessing the properties of Senegal gum, and for a handbook treating of the drugs used in the dyeing and printing industries; a medal of honour is offered for an economical substitute for dried egg-albumen, or for a decolourised blood-albumen for the same purpose. Other awards will be given for papers on the colouring matter or on the carmine in cochineal; the theory and manufacture of alizarin reds; the composition of aniline black; the transformation of cotton into oxycellulose; the composition of colouring matter and synthesis of a natural colour, various mordants, bleaching processes, and colours, &c. Papers, &c., must reach the Président de la Société Industrielle de Mulhouse, Alsace-Lorraine, before February 15, 1909. Further details may be obtained on application.

A canal of the width of rather more than 1000 feet is to be constructed through the island of Mühlenwerder, in the Elbe, where the Mühlenfeut joins the river, by which Hamburg will be enabled to use a considerable part of the island for future harbour construction, and to leave the waterway from the mouth of the Elbe to Harburg independent of Hamburg's shipping. Hamburg will in consequence be able to construct harbour basins independent of the part of the Elbe belonging to Prussia. The deepening and widening of the lower portion of the Elbe in 1896 resulted in the river being available for the increasing traffic and the larger dimensions of the vessels, but the improvements then made are no longer sufficient; hence the present proposal, the cost of the carrying out of which is estimated at 6,000,000*l*.

The April number (vol. ii., part i.) of the Records of the Indian Museum contains a notice of the retirement of Lieut.-Colonel Alcock from the office of superintendent of the museum. Colonel Alcock came to India in 1886 as a member of the Government Medical Service, and after two years' professional work on the N.W. frontier he was gazetted surgeon-naturalist to the Indian Marine Survey; his appointment to the superintendentship of the museum took place in 1893. A minute of the trustees records the value of his services to the museum and to biological science generally.

We have to acknowledge the receipt of a copy of the report of the Indian Museum for 1906–7, wherein attention is directed to the embarrassment caused by the smallness of the staff when two or three of its members are absent on leave. It is, however, hoped that a revised scale of pay will attract a better class of men to the posts filled by the non-gazetted members of the staff. Much satisfaction will be felt at the addition to the staff of a natural-history collector, and at the permission granted to the superintendent to visit various parts of India for the prosecution of faunistic and bionomical researches.

The ravages of the coffee disease are so fresh in the memories of the inhabitants of Ceylon that it is no wonder the appearance of the bleeding disease of the cocoa-nut

trees caused considerable alarm in the colony. Fortunately, however, they are now better prepared to resist the attack of an epidemic caused by a parasitic fungus than they were twenty-five years ago. For one thing, they have a resident official mycologist who was able at once to tell them what steps to take to prevent the spread of the disease, and the growers were ready, if not eager, to take them. The illustration shows a young cocoa-nut tree destroyed by the disease (*Thielaviopsis ethaceticus*, Went.). The first appearance consists of a rusty or dusky bleeding patch on the stem, which is subsequently followed by others. As soon as the crown or "cabbage" is affected the tree dies, as in the figure. A bleeding patch is seen just above the level of "podion's," or boy's, head, and there are two other smaller ones higher up. Young trees succumb much sooner than old ones. The remedy recommended by Mr. T. Petch consists in cutting out the diseased areas with a chisel, searing the cavities, and applying hot coal-tar.

Earwigs are generally supposed to make but very occasional use of their complexly folded wings. In the August issue (vol. iii., No. 2) of the *Journal of Economic Biology* Mr. W. E. Collinge records, however, that on many evenings in June and July last a considerable number of these insects was observed on the wing, apparently in the neighbourhood of Berkhampstead. Individuals—all males—ranging in number from seven to eleven flew into a single lighted room on three evenings, thus indicating that many more must have been on the wing out-of-doors.

An article treating of the cotton varieties in Egypt is contributed by Mr. W. L. Balls to the *Cairo Scientific Journal* (July). The author, discussing the mixed nature of the crop, attributes it not only to the number of varieties, but also to the developments arising out of interplanting and natural crossing. With regard to the origin of the Egyptian cottons, while it is possible to indicate the source of one or two, such as Abassi and Yannovitch, the source of most of the varieties is indeterminable. Also it is noted that unless the original strain is pure, there must be continual breaking away from the type. A scheme for improving the crop is foreshadowed in connection with an experiment station that is being founded by the Khedivial Agricultural Society. The plan consists in obtaining pure varieties by selection or crossing, and the maintenance of such pure varieties by special precautions.

The current number of the *Kew Bulletin* (No. 7) opens with a short account, communicated by Mr. G. Massee, of the fungus *Naemospora crocea*, that causes "die-back" of peach shoots. The genus falls in the group of "fungi imperfecti," as only the conidial reproductive stage is known. Conidial infection is limited to shoots of the year's growth. Mr. A. L. Simmons, adding to the list of Lepidoptera taken in the gardens, records the discovery of pupæ of the spurge hawk-moth and the capture of a swallow-tail butterfly. There are also published analyses of the tuberous roots of the new Ecanda rubber plant *Raphionacme utilis*, and an article on the cultivation of the date-palm in Mesopotamia.

Mr. P. S. Sparkman, an Englishman settled in San Diego County, California, devoted his life to the study of the Luiseno tribe of Indians, among whom he lived. Before his murder in May, 1907, he had completed a dictionary of the native dialect and an account of the culture of the tribe, the latter being now issued as a part of vol. viii. of the University of California memoirs on archæology and ethnology. The culture of the tribe presents no features of special interest, that of the neighbouring and allied tribes having been already illustrated in other issues of the same series. Their food largely consists of various kinds of acorns, for the crushing of which a stone mortar is required. This is formed by chipping in a rock a slight cavity, round which a basin-shaped basket is fixed with pitch to prevent the contents from flying out when struck by the pestle. With constant use this cavity becomes deeper and deeper, until the basket, being no longer necessary, is removed. The tribe supplies an excellent example of that curious institution, the Couvade. The father for some time after the birth of a child is obliged to take as much care of himself as the mother does. He must not take cold, lest the health of the infant might be endangered; he cannot drink cold water in winter; he must eat the same diet as that prescribed for the baby. If the child dies, its mother attributes her loss to his neglect of these precautions. We have also a full account of the initiation rites, and the writer has been lucky enough to procure a full record of the exhortation addressed by the person in charge of the rite, who carefully explains, with appropriate warnings, the rules of life and etiquette which the boys and girls are expected to obey. Morals, in fact, merely mean the observance of the long-established customs of the tribe, and do not include those higher rules of conduct which the codes of more advanced societies prescribe.

Throughout Africa are played games, usually between two players, which consist of transferring counters from one hole to another; formerly these have been classed by ethnologists under the Nubian name of *mangala, mankalah*, &c., but Captain R. Avelot (*Bull. Soc. d'Anth.*, Paris, 1908, p. 9) distinguishes three types, for which he adopts the names of *tshéla* for the games of skill, *tab* for games of the backgammon group, and *ouri* (*uri*) for games of mathematical combinations. The author mentions the distribution of the three types, and gives a map of the spread of hole games, more particularly of *uri*, as well as a list of the native names for these games. He concludes that *uri* may be considered as absolutely African, which appears to have arisen among a Hamitic tribe in the neighbourhood of Ethiopia, whence it has been spread (*a*) by the Fulah across south Sahara to Senegambia, and thence to Guinea and Gabon; (*b*) by Nubian slave-merchants, who took it down the Nile; (*c*) by the Jaggas, who, skirting the south of the equatorial forests, carried it to Angola; (*d*) by a Negro-Hamitic people it proceeded south as far as Manica. The hole games have nothing to do with cup-markings. Although the author in this and his earlier paper (*Bull.*, 1906, p. 267) gives numerous references, he has overlooked S. Culin's paper, "Mancala, the National Game of Africa," Report U.S. Nat. Mus. for 1894 (1896), p. 597, and Flinders Petrie's remarks in "Egyptian Tales," 2nd series, 1895, p. 136.

The lake dwellers of Lower Dahomey, who have been studied by Major-Surgeon Gaillard (*l'Anthropologie*, xviii., p. 99), do not present many analogies with the inhabitants of aquatic pile-dwellings of Malaysia and New Guinea. In some cases the village in the water is opposite one of the same name on the land, and there is evidence in favour of the view that the natives were driven to build on the lake to escape the depredations of the Dahomians, who could not cross the water on account of the fetish customs. The lake-dwellers are not attached to their condition, and during the existing state of political security have returned to the ordinary agriculture of the district, though still remaining fisher-folk, and a great number have built ordinary land houses, but these are accused by those who remain faithful to the pile-dwellings of being incapable fishermen. Fishing grounds are free to all. The miserable condition of their houses is due to a lack of forethought and a passion for tobacco and alcohol.

The Corps of Mining Engineers of Peru has issued a *Boletin* (No. 57), by Mr. E. A. L. de Romaña, on the tin deposits of Bolivia and prospecting for tin in Peru. Covering 100 pages, with twenty-eight illustrations, it is the most complete memoir on the subject, and is of special interest at the present time, when growing uneasiness prevails that many of the world's best tin deposits are becoming exhausted, and that the price of the metal may possibly become quite prohibitive for many industrial purposes before long. In Bolivia it is evident that the prospects are good. That country now ranks second only to the Federated Malay States as a tin-producing district, and it is probable that the production will continue to increase. Careful exploration has been made in Peru in the provinces of Huancané and Chucuito, which are the nearest to the Bolivian tinfields, but with the exception of some samples of stanniferous lead ore found at Vilque Chico, no indications of tin were discovered. Another *Boletin* (No. 56) issued by the Corps of Mining Engineers of Peru deals with the problem of the irrigation of the valley of Ica.

THE records of the Mysore Geological Department (vol. vii.), which have just been received, contain general and special reports of work done from July, 1905, to June, 1906. The year was an eventful one in the history of mining in Mysore owing to the attention devoted to the mineral resources by European and native capitalists. Chief among the ores sought were those of manganese and chromium. Other minerals which engaged attention were magnesite, asbestos, and chromium. The new goldfield near Lingadhalli gave good indications. The value of the gold raised in the Kolar area during the year was 2,274,786*l*. The results of the work of the Geological Survey during the year are given in special reports by Mr. H. Kelsall Slater and Mr. P. Sampat Iyengar. The former made a geological survey of 180 square miles in the Kadur district. The boundary of the granite extending from Tarikere westward was mapped, and found to conform generally with the base of the hills. The schists composing the hills are invariably associated with the occurrence of gold. Numerous old workings were discovered, and the area deserves careful prospecting, as it bids fair to prove another valuable goldfield. In the Mysore district the felsite and porphyry dykes of Seringapatam were mapped. In the Tumkur district traces of gold were found, and the native workings of grey corundum are described. Reports are also given on the geology of the Srinivaspur and Kadri Taluks, and of parts of Challakere and Sira Taluks. An appendix is devoted to a detailed description of important felsite and porphyry dykes in the neighbourhood of Seringapatam. When polished they yield very handsome ornamental and building stones.

IN his "Studies on the Thermodynamics of the Atmosphere," published under the auspices of the Weather Bureau, U.S. Department of Agriculture, Prof. F. H. Bigelow collects nine papers which he had contributed during 1906 to the *Monthly Weather Review*. They deal with a variety of subjects, including the meteorological conditions characteristic of different parts of cyclones and anticyclones in Europe and America during summer and winter. The temperature gradient at different levels receives special attention. The last four papers deal with a waterspout, or waterspouts, seen near Cottage City, Mass., in August, 1896. In most of the papers, even those relating to the waterspout, there is a rich profusion of statistical data, conversion factors, and mathematical formulæ. There are sixty-seven tables and forty illustrations, including ten full-page photographs of the Cottage City waterspout at different stages of development. A large number of conclusions are also drawn. The papers provide evidence of industry and imagination, and the conclusions and observational data will no doubt receive the critical examination of meteorologists.

A CORRESPONDENT has written to point out that Prof. von Thán, to whose memory a monument is to be erected at Ó-Becse, Hungary (see NATURE, August 27), held the chair of chemistry from 1862 in the University of Budapest, and not that of the University of Vienna.

## OUR ASTRONOMICAL COLUMN.

DISCOVERY OF A COMET, 1908*c*.—A telegram received from the Kiel Centralstelle announces that a new comet was discovered by Prof. Morehouse, of the Drake University Observatory, Des Moines, Iowa (U.S.A.), on September 1. At 8h. 40m. (Yerkes M.T.) on that date the position of the comet was

$$\text{R.A.}=3\text{h. } 20\text{m., dec.}=66^\circ\ 15'\ \text{N.},$$

and it was reported as moving rapidly in either a south-east or north-west direction. It was also said to possess a long, conspicuous tail.

A second telegram states that this object was observed by Prof. Thiele at Copenhagen on September 3, its position at 10h. 29·6m. (Copenhagen M.T.) being

$$\text{R.A.}=3\text{h. } 19\text{m. } 43\text{s., dec.}=67^\circ\ 14'\ 42''\ \text{N.},$$

so that the motion is north-west. This observation gave the magnitude of the comet as 9·0. The present apparent path lies through Cassiopeia towards Cepheus, and the comet does not set below the horizon in London; it reaches the zenith about 4 a.m., and should therefore be an easy object for telescopic observation.

The comet was quite easily found with a $3\frac{1}{4}$-inch equatorially-mounted finder at South Kensington on Friday night, September 4, and in the 10-inch refractor, with a power of 100, appeared as a very diffuse, nebulous patch with scarcely a trace of any stellar nucleus.

LARGE SUN-SPOTS.—The large sun-spots illustrated in these columns in our issue of August 13 have again appeared round the eastern limb of the sun. They were first re-observed at South Kensington on August 27, and have since been visible to the naked eye. On August 29 a new, large spot followed, and on September 1 the large group, two large single spots, and a smaller group were to be seen on the disc. For the actual epoch of solar activity the disc is, therefore, displaying a remarkable amount of spotted area.

RECENT METEORS.—Some interesting notes on meteors recently observed are published by Mr. Denning in No. 400 of the *Observatory* (p. 350, September). Mr. Denning remarks on the favourable conditions for meteor observations that obtained during the present summer, and states that on fifteen dates between July 18 and August 8 he observed 204 meteors during $20\frac{1}{2}$ hours. Of these, more than half were traced to known radiants, forty-two of them being Perseids. During the period July 26 to August 7, the Perseid radiant moved from $25^\circ, +53^\circ$, to $41^\circ, +56^\circ$; a late Perseid was seen, on August 17 at 9h. 25m., which left a fine streak, and was directed from $51^\circ, +58^\circ$; another, of the first magnitude, was seen on August 19d. 9h. 44m., and its direction was from a point at $56^\circ, +60^\circ$.

For the period June 25 to August 10, Mr. Denning received duplicate observations of ten meteors, for which he gives the particulars of the real paths.

$D_3$ (HELIUM) ABSORPTION IN THE SOLAR SPECTRUM.—In a letter to the *Observatory* (No. 400, September, p. 353) Captain Daunt reports that he believes he observed $D_3$ dark in the solar spectrum when making visual spectroscopic observations of the large sun-spot group which was near the eastern limb on August 1. The line had much the same appearance as that shown on the photograph taken by Mr. Nagaraja at Kodaikánal last year, running as a fairly fine dark line, somewhat thickened in the centre, right across the group. Although the sun was getting low at the time—between 5 p.m. and 6 p.m.—Captain Daunt believes that the line seen was not of atmospheric origin, for he was unable to see it anywhere else on the disc, and it stopped short a little way on either side of the penumbra.

THE SPECTRUM OF THE NEBULA HV 15 CYGNI.—The spectrum of the Milky Way nebula HV 15 Cygni was photographed by Prof. Max Wolf with the Waltz reflector on August 3. An exposure of $3\frac{1}{2}$ hours was given, and the resulting spectrum shows the light-source to be gaseous.

By far the brightest line is that at the violet end of the spectrum, $\lambda$ 373; the line at $\lambda$ 434, the band at $\lambda$ 500, and the lines at $\lambda\lambda$ 369, 397, and 411 are also present, but faint, their intensities being in this order. Possibly there is also a line at $\lambda$ 360, but this is doubtful. Prof. Wolf hopes that by having his mirror re-silvered he will be able to obtain a much stronger spectrum (*Astronomische Nachrichten*, No. 4271, p. 379, August 29).

THE PARIS OBSERVATORY.—M. Baillaud's first report as director of the Paris Observatory gives an account of the work performed during 1907, and follows its predecessors in general form. Among the records of a vast amount of routine work performed there are one or two points of general interest which call for special remark.

During 1907 the "cercle meridien du jardin" was employed solely for the study of recent improvements to the instrument, and the report gives the results at some length. The automatically registering micrometer has given unhoped-for precision; the difference of personal equation amongst the observers is practically absent, and shows no variation with the magnitude or with the amount or direction of the motion of the observed object. The mean error of a passage is reduced to $\pm$0·03s. instead of the $\pm$0·05s. obtained by practised observers using the electric method and $\pm$0·07s. with the eye and ear method. It is hoped to complete the tenth fascicule of the "Atlas photographique de la Lune" during the current year, and it appears necessary that, in order to complete the work satisfactorily, two more fascicules must be issued.

The new stellar spectroscope, of which M. Baillaud gives an illustrated description, is used, in conjunction with the equatorial *coudé*, for the determination of radial velocities, and, with its greatest dispersion, gives a spectrum in which, at H$\gamma$, each millimetre includes four Angström units. The time service and the *carte du ciel* work have been carried on as usual, and for the latter full statistics are given showing the progress made.

## INSTITUTION OF MINING ENGINEERS.

THE nineteenth annual general meeting of the Institution of Mining Engineers, which was held in Edinburgh on September 2–4, was largely attended, and was altogether a most successful gathering, the papers, discussions, and excursions being all of more than ordinary interest. Dr. R. T. Moore (Glasgow) was elected president for the ensuing year. The annual report showed that the membership was considerably more than 3000. It was announced that owing to the death of the secretary, Mr. M. Walton Brown, various changes had been found necessary. The headquarters of the institution would be moved from Newcastle to Westminster, and Prof. L. T. O'Shea (Sheffield University) was appointed honorary secretary and Mr. P. Strzelecki assistant secretary.

Of the five papers on the programme, the first read was by Mr. Henry Hall, H.M. Inspector of Mines, on coal-dust and its treatment with calcium chloride. He dealt first with the history of coal-dust in relation to colliery explosions. The first reference to the matter was in a report by John Buddle in 1803, but it was not until 1874 that it began seriously to be argued that coal-dust could of itself cause a colliery explosion in the absence of fire-damp. At the present time coal-dust is regarded as the chief agent of destruction. Experiments made by the author showed that the quantity of coal-dust deposited day by day in a mine is much less than is usually thought. When once the roads have been made clean it is easy to keep them so. Watering with the view of laying the dust is impracticable where the rocks are friable shales, as it tends to cause accidents from falls of roof and side. Calcium chloride promises to obviate the difficulty. The application of the solution, or, better still, of the dry powdered salt, is effective for three months. The discussion was well sustained. Mr. H. M. Cadell suggested that a cheaper hygroscopic material, such as common salt, might be tried. Mr. Bennett Brough mentioned that calcium chloride was being successfully used in Washington on macadamised roads to obviate the dust nuisance. Mr. W. C. Blackett stated that calcium chloride had proved efficacious in a Durham colliery.

The next paper read, that by Mr. G. B. Walker, on the practical use of colliery rescue apparatus, embodied a set of rules for the use of such apparatus. He was of opinion that the course that would be adopted in this country was to have central rescue stations maintained by the coal-owners' associations. In the discussion it was suggested that there was a danger of the possibilities of rescue apparatus being exaggerated. Mr. W. E. Garforth, however, strongly supported the views expressed in the paper, and Mr. C. E. Rhodes believed that, apart from the humanitarian aspect of the question, there was great use for the apparatus in saving property in mine fires.

The paper by Mr. John Gemmell on the Wemyss coal-field contained much interesting historical detail compiled from the journals of the second Earl of Wemyss (1610–1679), who devoted careful thought to the development of the coal seams on his estates. The review of the present condition of the mines contained much information of value. A diamond bore has just been put down on the estate to the enormous depth of $4534\frac{1}{2}$ feet. Temperature observations were made, the lowest reading taken being at a depth of 3955 feet, where the temperature was 92°·2 F., giving an average thermal gradient from the surface of 1° F. in $87\frac{1}{2}$ feet. In the discussion Mr. Brough emphasised the value of the temperature observations in this bore-hole, as it was probably the deepest in Great Britain. The temperature increase was lower than the average of the observations collected by the British Association Underground Temperature Committee. Mr. J. S. Dixon suggested that this discrepancy could be explained by the cooling action of the flow of water encountered at depths of 1577 feet and 1827 feet. Papers by Mr. J. G. Thomson on the deep diamond boring at Balfour Mains, Fifeshire, and by Mr. William Caldwell on the working of oil shale at Pumpherston, were taken as read, and the proceedings terminated with the usual votes of thanks. On September 3 the members visited the Wemyss collieries and the Pumpherston oil works and shale mines, and on September 4 there was a steamer excursion to the Kyles of Bute.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DUBLIN.—In connection with the meeting of the British Association, the following honorary degrees have been conferred:—*D.Sc.*, Mr. Francis Darwin, F.R.S., Sir David Gill, K.C.B., F.R.S., Dr. William Napier Shaw, F.R.S., Captain Henry George Lyons, F.R.S., Prof. Horace Lamb, F.R.S., Prof. Charles Scott Sherrington, F.R.S., Prof. Ernest Rutherford, F.R.S., Prof. Archibald Byron Macallum, F.R.S., Dr. Albert Kossel, and Dr. Ambrose Arnold William Hubrecht; *M.D.*, Sir Thomas Lauder Brunton, Bart., F.R.S.; *LL.D.*, Sir James Augustus Henry Murray.

THE new building of the engineering laboratory of the Heriot-Watt College, Edinburgh, will be opened by the Earl of Rosebery on September 16.

THE Board of Education has issued (Cd. 4288) the first part of "Statistics of Public Education in England and Wales, 1906–7–8." The present part is confined to educational statistics; the second part, which will appear later, will deal wholly with financial statistics. The number of technical institutions in England recognised by the Board during 1906–7 was 31, and the number of teachers therein 521. The Board defines a technical institution as one giving an organised course of instruction in day classes, including advanced instruction in science or in science and art, and provided with a staff and equipment adequate for the purpose. The number of students who attended these institutions at any time during the year was 2655 (including 325 girls and women), and 1446 of these attended a full course of instruction. Of the 2330 boys and men attending, 542 were under seventeen years of age, and 469 were twenty-one years of age or more. The number of evening schools and classes in England recognised by the Board for the education of persons already engaged in some occupation which takes up the greater part of their time was 5368 in 1906–7. These classes varied very widely in character and scope; 29,946 teachers were employed in them, and 687,681 students attended during the year, and the Board paid grants on account of 515,897. There were in the same year 676 secondary schools in England recognised by the Board as eligible for grants as compared with 600 in the previous year. These schools accommodated 62,712 boys and 50,877 girls, the numbers in the preceding year being respectively 60,353 and 44,681.

THE regulations which deal with the position of *agrégé* in the Paris faculty of medicine and the joint faculty of medicine and pharmacy have, according to the Paris correspondent of the *Lancet*, recently been modified by the Minister of Public Instruction. The new regulations will not, however, come into force until the commencement of the scholastic year 1909–10. The qualifying examination consists of three sections:—(1) anatomy, physiology, physics, chemistry, and natural science; (2) medicine; and (3) surgery and obstetrics. In the first and third sections special branches may be taken according to the particular branch to which the candidate has devoted himself. The course of the examination is as follows:—(1) a written essay in anatomy, physiology, and histology; (2) a *viva voce* examination, lasting three-quarters of an hour, in general pathology; (3) a clinical examination; and (4) an examination in practical pathological anatomy. Once a candidate has been declared qualified he maintains his position for life, and all candidates who were qualified in examinations held previously to November, 1907, are dispensed from the above-mentioned examinations. For admission as *agrégé* the following tests have to be passed:—(1) The candidate must hand in his testamurs and other documents (*titres*). (2) He must give a lecture of one hour's duration without an assistant or notes. Four hours are allowed for the preparation of this lecture. (3) Practical work.

PROF. JOHN W. GILMORE, of the Pennsylvania State College, has been chosen president of the College of Agriculture and Mechanic Arts of Hawaii, situated at Honolulu, which was opened on Friday last.

THE report for 1908 of the president of Yale University states that plans for the immediate future at the University involve the development of courses in regional geography until there are instructors who are authorities on the geography of each of the continents. This will eventually necessitate the erection of a separate department of geography, which will not only offer courses, but will also conduct explorations in the less known parts of the world, particularly those parts where the character of the physical features has been a prominent factor in the life of a race, such expeditions being in charge of officers of the department, and including advanced students.

MR. A. H. MACKENZIE, of the University of Aberdeen, has been appointed professor of science and manual training at the Allahabad Training College for Secondary Teachers.

AN exhibition of the work of teachers and pupils of Indian schools of general education is to be held in Mysore on October 6–12 next. Five classes of exhibits are to be arranged for, namely, infant and primary schools; secondary schools for boys; secondary schools for girls; collections of objects suitable for school museums; and records of teachers' work. A number of English exhibits are to be sent by the English Board of Education and the Director of Public Instruction, Madras.

## SOCIETIES AND ACADEMIES.

### PARIS.

**Academy of Sciences**, August 31.—M. Bouchard in the chair.—Concerning *Trypanosoma congolense*: A. **Laveran.** Details are given of experiments on goats. In one case the animal acquired complete immunity against *T. congolense*, but this immunity did not extend to infection by *T. dimorphon*. In the second case, immunity against *T. congolense* was also attained, and experimental inoculations with *T. dimorphon* are in progress.—Pfaff's problem: A. J. **Stodolkievicz.**—Periodic functions: P. **Cousin.**—The temperature of dissociation of ammonia and carbon monoxide: Herman C. **Woltereck.** Ammonia, carefully purified from moisture and traces of organic matter, was passed through a Jena glass tube, the temperature of which was controlled by a Le Chatelier pyrometer. The first traces of dissociation were observed at 620° C.; the lower temperatures noted by other investigators are probably due to the presence of traces of impurity. Carbon monoxide commences to dissociate between 570° C. and 580° C.—The white disease of the oak and *Erysiphe quercus*: M. **Boudier.**—The action of human serum on *Trypanosoma pecaudi*. The differentiation of *T. pecaudi* and *T. gambiense*: A. **Thiroux** and L. **d'Anfreville.** From experiments on apes it is concluded that human serum exerts a preventive and curative effect as regards infection with *T. pecaudi*, and this effect falls off very slowly.

### NEW SOUTH WALES.

**Royal Society**, June 3.—Mr. W. M. Hamlet, president, in the chair.—The viscosity of water: Richard **Hosking.**—Note on a cupriferous porphyrite and quartz veins in the Nelligen district: Dr. H. I. **Jensen.** The author briefly describes a curious basalt formation between Nelligen and Braidwood which contains inclusions of schist, limestone, reef quartz, and quartz porphyry, and in addition small bunches of native copper and copper ores. Unlike the Bumbo basalts, this basaltic rock contains no copper at all except in the vicinity of the other inclusions. It is inferred that the copper, in common with the other xenoliths, has been torn out of a mineral vein along which the magma found egress to the surface. A number of quartz veins which cut out in both directions, or in depth, occurring in the same district, are attributed to pneumatolytic processes in the period in which the ancient palæozoic rocks underwent metamorphosis.

## CONTENTS.

THURSDAY, SEPTEMBER 17, 1908.

## *SEWAGE WORKS.*

*The Design, Construction, and Maintenance of Sewage Disposal Works.* By Hugh P. Raikes. Pp. xv+414. (London: Archibald Constable and Co., Ltd., 1908.) Price 16*s*. net.

THOSE entrusted with the design and construction of sewage works should have at their disposal the latest results of contemporary science to guide them, and the author's contention that no other book has recently been published from which equally full and trustworthy information can be obtained by the engineer is substantially correct, with the reservation that the information alluded to has reference to recent developments. Judged from this standpoint, the volume is likely to appeal to the engineer, since it summarises a considerable amount of recently acquired knowledge relating to sewage disposal, and contains the advice and experience of one who has had to face the practical problems involved.

From the circumstance that the work contains much elementary matter, more especially in the opening parts, it appears that it is not designed exclusively for advanced students; and that being so, this matter should be extended so as to meet the needs of those who approach the subject with comparatively little knowledge; for some of the bacteriological and chemical references in this volume are insufficient for the student's comprehension as they stand at present, and in some cases they demand revision in a subsequent edition.

To give instances, on p. 162 it is stated that "the best results have been obtained with a solution of bleaching powder containing hypochlorite of calcium having 36·35 available chlorine." On p. 143 the value of copperas as a chemical precipitant is discussed in a way which infers that its main virtue depends upon its acidity and the fact that its use in conjunction with lime prevents an excessively alkaline effluent. On p. 31 the author states that "the difference in the composition of sewage in different places may be as great as that between milk and writing ink." While conceding that great differences exist, the comparison is, to say the least, an unhappy one. There is no chemical or physical justification for it.

On p. 35 the author remarks, with reference to sewage effluents, that "the presence of a few disease germs cannot be considered of vital importance so far as water supplies are concerned when the water is again filtered before use." On p. 52 he states that

"the danger of disease cannot be indicated by the mere numbers of any particular disease-producing micro-organisms that may happen to exist in samples"—of polluted water or shell-fish—"so that for the present, at any rate, topographical observations must be regarded as the only reliable means of detecting objectionable contamination."

The following statement on p. 71 is not very clear:—

"It would therefore seem to be a very much simpler matter to sterilise the shell-fish or water supplies than to deal with sewage effluents in this way, as no such system could be relied upon to remove all danger of contamination, and the consumers would still have to rely for protection on those who supply them with water or shell-fish as the persons directly responsible for their freedom from contamination."

The author very justly directs attention to the circumstance that local authorities all too frequently appoint as managers of sewage works individuals who have neither an adequate understanding nor appreciation of the duties appertaining to such a post, nor the qualifications which are necessary to enable them to fulfil those duties satisfactorily. He then proceeds to lay down some of the qualifications which a good manager should possess; and one is astonished to find the following paragraph on p. 367:—

"The increasing attention now being devoted to the study of bacteriology in connection with sewage disposal also renders it highly desirable that a manager should understand the methods of cultivating, counting, and distinguishing the different kinds of bacteria to be found in sewage, so that he may be able to observe the conditions that are favourable or unfavourable to their growth, and thus ascertain the best means of developing the growth of those which are useful for decomposing the sewage while at the same time destroying the pathogenic or disease-breeding bacteria, which may sometimes constitute an even greater source of danger in the final effluent than chemical impurity."

Placing the broadest construction upon the above sentence, how many expert bacteriologists in this country possess the knowledge held to be highly desirable in a manager of sewage works?

Chapters vii., viii., and ix., dealing with contact beds and percolating filters, may be singled out as the best in a volume which, from the engineering standpoint, justifies its appearance. It cannot fail to prove useful to those engineers who do not possess a first-hand knowledge and experience of sewage disposal, for the practical engineering facts are sound and up-to-date, and the requirements of the Local Government Board, the reports of the Royal Commissions, &c., are usefully summarised within the volume.

## *MATHEMATICAL INSTRUCTION.*

*A Study of Mathematical Education, including the Teaching of Arithmetic.* By B. Branford. Pp. xii+392. (Oxford: Clarendon Press, 1908.) Price 4*s*. 6*d*.

BY far the most valuable part of this book consists of the examples which it gives of the curiously limited powers of generalisation and abstraction possessed by young pupils. For example (p. 44), a class, after experimentally adding angles together, agreed that four angles could be added, but not five. A still more remarkable case is described on pp. 304–9. A little girl was given three congruent paper triangles A, B, C; after fitting A to B and A to C, she not only failed to draw the conclusion that B could be fitted to C, but refused to admit the force of arguments to that effect. This result was confirmed by experiment with another little girl, and shows plainly enough that premature formal teaching must be injurious by destroying independence of thought. Unfortunately, the ages of the girls are not stated.

The volume is very miscellaneous, and, indeed, suffers from the fact that addresses, lectures, notes, &c., have been gathered together without much attention to revision or general effect. There are notes on lessons in geometry (often good), a long extract from an address by Bidder to the Institution of Civil Engineers, scraps of mathematical history, and a certain amount of that twaddling "psychology," so-called, and puerile classification, in which pædagogists take such unaccountable delight. For instance, we are solemnly told that "Geometry is the resultant of *Sense-Perception* and *Abstract Thought*," a statement equally true of all the sciences and most of the arts. Then we have a strobic disc, supposed to indicate the different proportions, at different ages, of perception to abstraction, and a so-called chart, something like a toy-trumpet or a church spire, to indicate the stages of mathematical progress in the race and the individual. This last is distinctly misleading, because it makes the advance linear, and it has been nothing of the kind, so far as the race is concerned.

The bibliography is neither discriminating nor up to date. Montucla and Marie are mentioned without a hint that, as works of reference, they have been made obsolete by M. Cantor's history; and the latter is described (without date) as in three volumes, whereas five complete volumes have appeared, and vols. ii. and iii. are in a second and revised edition. No mention is made of Merz's "History of European Thought," which has some very good sections on mathematics, or of Heath's studies of the Greek geometers.

But in spite of these defects the book is worth reading, and the author's views appear to be sound. Thus he realises that one great practical problem is to find out, if we can, how far the education of the race should be imitated in that of the individual; he has a reasonable idea of the proportion of experiment to theory in teaching geometry to boys and girls of different ages; and he very properly recommends the study of algebra, in its early stages, as a generalised arithmetic. Few will dispute that mechanical algebra does more than anything else to blunt a boy's mathematical faculties.

On pp. 352–6 there are samples of old algebraic notation, on pp. 356–60 a good collection of fallacies, and there is an index of twelve pages. G. B. M.

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## THE ORIGIN OF THE SOLAR SYSTEM.

*Das Problem der Entwicklung unseres Planetensystems, Aufstellung einer neuen Theorie.* By Dr. Friedrich Nölke. Pp. xii+216. (Berlin: Julius Springer, 1908.) Price 6 marks.

THOUGH it is perfectly true, as the author reminds us, that the problem of the origin of the solar system has attracted the attention and exercised the ingenuity of the foremost minds in all ages, it is easy to recognise decisive steps in the gradual development, rendered possible by the acquisition of new and epoch-marking facts. Such were the discovery of the theory of gravitation, the modern views concerning the conservation of forces, and it is not impossible but that in theories yet to be broached, the recent conceptions as to the nature of matter may considerably modify the views that have hitherto been regarded as orthodox. Our theory of the cosmos is progressive, and continued adjustment is necessary to accommodate our conceptions to observed facts. Dr. Nölke reopens the graves of a long succession of these theories which have undergone amendment, and naturally finds them inadequate to explain phenomena with which their authors were unacquainted. But in any case, since Dr. Nölke is the author of a rival theory, he could not be satisfied with the work of his predecessors. To destroy is easier than to build, and he has little difficulty in pointing to many shortcomings; but though he confidently believes that he has removed all the objections that disfigure the efforts of earlier physicists, and is in possession of an absolutely flawless conception, it is not impossible but that his views will also pass into the limbo of discredited statements when reviewed by critics as severe as he has proved himself.

As in the theory of Moulton, the author starts with a spiral nebula resembling that in Canes, but with more delicate convolutions and a smaller mass. In that nebula an outlying portion is seen apparently detaching itself, and Dr. Nölke regards the formation of Neptune to have been accomplished in a similar manner. He next supposes the connecting link that holds the newly-formed Neptune to the original nebula to separate itself from the parent nebulous mass and the detached Neptune to make a Uranus. Saturn and Jupiter are formed by analogous processes. Within the internal folds of the spiral there apparently exists a mass of greater density, with four other regions of condensation surrounded by flocculent matter. This latter incoherent material formed the asteroids, while the condensations towards the centre gave rise to the four internal planets. Then, by the action of molecular forces and the "resistance of the æther," the slowly rotating sphere of gas forming the innermost nebula contracted, and the sun was produced. To bring about the necessary contractions and separations, the author has to introduce within the nebulous mass the action of other forces than those of gravitation, and to give to the æther a resistance which we fail to understand. But it is permitted to hold very varied views of the constitution of the æther, and possibly we have failed to grasp exactly the author's contention. We are willing to give him every latitude in this undecided question, but when he goes on to explain the occurrence of the Ice age on the earth as due to the passage of the sun through a nebulous mass, and selects the Orion nebula as the most probable, we feel that our guide becomes untrustworthy. Moreover, to use such a hypothesis as affording the means of determining the density of the Orion nebula must be regarded as unwarranted and calculated to bring into disrepute any points of merit the theory may possess.

## OUR BOOK SHELF.

*The Influence of Alcohol and other Drugs on Fatigue.* The Croonian Lectures delivered at the Royal College of Physicians in 1906. By Dr. W. H. R. Rivers. Pp. viii+136. (London: Edward Arnold, 1908.) Price 6*s.* net.

IN these the Croonian lectures delivered before the Royal College of Physicians, London, in 1906, the author details the results obtained in an experimental research on the influence of certain drugs—caffeine, alcohol, cocaine, strychnine, and tobacco—on muscular and mental fatigue. The method employed for estimating muscular fatigue was by means of an ergograph, the latest form of Kraepelin's modification of Mosso's instrument, the records being obtained graphically in the form of an ergogram, and representing the movements of one joint. Mental fatigue, or more precisely the fatigue of attention, was studied by McDougall's method, in which the subject has to hit a succession of dots which pass before him across a slit. Many factors which may influence the results were recognised and allowed for, such as the effects of attention, interest in the work, conversation, the habitual use of the substances experimented with, *e.g.* caffeine in tea and coffee, alcoholic drinks and smoking, &c. The disturbing influence of such factors was very well shown, for example, in the case of tea and coffee—withholding these beverages before commencing the experiments with caffeine was found to be followed by a loss of energy, so that the earlier ergographic records became untrustworthy as indicating the effects of caffeine when administered. The flavour of the drugs also had to be disguised, so that the subject was unaware when he was or was not taking them.

The general results obtained may be summarised as follows:—caffeine in moderate doses (about 0·3 gram of the citrate) increases the capacity for both muscular and mental work, the stimulating action persisting for some time, and not being followed by any depressant action. Excessive doses, however, after a transitory stimulant action, are followed by a depressant action so marked that the drug in such circumstances becomes an accelerator of fatigue; in fact, caffeine may be a dangerous remedy in cases of prolonged fatigue.

Alcohol in small doses (5–10 c.c.) seemed to produce little effect, in larger doses (20–40 c.c.) the action was variable; in a subject not used to alcohol, sweating, giddiness, and other symptoms often ensued; the muscular work was at first increased, afterwards diminished, but there was a good deal of irregularity in the results, and this portion of the research is being continued, and the problem is one of great complexity. The capacity for mental work on the whole seemed to be lowered.

The researches carried out by Dr. Rivers are of great interest and importance, and it is to be hoped that they will be continued and extended to the other drugs mentioned.

*The Moral Ideal; a Historic Study.* By Julia Wedgwood. New and revised edition. Pp. xi+504. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1907.) Price 10*s.* 6*d.* net.

THE first edition of this book was published twenty years ago. It is indicative of the soundness of the original work as well as of the completeness of the revision that the numerous interpolated references to recent events and contemporary thought seem never to have an adventitious but always a natural and integral connection with the context in which they appear. The book is intended to be a contribution to the "history of human aspiration," which the author regards as "the clue to all history," believing that "a partial and incomplete revelation of what men have sought to be tells us more of their true nature than does the most exhaustive record of what they have accomplished." From this point of view she gives a number of studies of the moral ideals which may be taken as characteristic of the races whose life has at different times formed part of the main stream of human progress. The spiritual histories of Egypt, India, Persia, Greece, and Rome are reviewed in succession, and an attempt is made to signalise the elements of cardinal importance which each has contributed to the moral development of Europe. Chapters follow dealing with the evolution of the moral consciousness of Christianity out of the mingled elements of eastern and western origin, while in a final study the author seeks to determine the relation of these earlier aspirations to the moral life of the present day, and considers, in particular, the relations between morality and modern science.

In her earlier chapters Miss Wedgwood appears to have followed the recognised authorities upon oriental history and religion, but from the point where she reaches the study of Greek ideals she depends largely upon her own reading and observation, and displays a fund of erudition as striking in profundity as it is engaging in quality. The variety and beauty of her illustrations from many literatures would alone suffice to make her pages interesting and impressive even if they were not decorated by the writer's own eloquence, sweetened by her catholic sympathy, and illuminated by her splendid moral enthusiasm.

*Electricity: What is it?* By W. Denham Verschoyle. Pp. xii+259. (London: Swan Sonnenschein and Co., Ltd., 1908.) Price 2*s.* 6*d.* net.

THE main object of this book is to sustain the contention that something more than the usually accepted electrical idea is needed if we would aim at solving the many problems which exist around us.

To solve these problems on the modern electrical theory, it is generally recognised that we still require as postulates:—(1) Positive electricity, (2) negative electricity, (3) an attractive force between them, (4) æther, (5) gravity, (6) life. "There seems at present no possibility of further consolidation in these premises; they remain, as between themselves, isolated facts, having no relation to one another. We cannot express life in terms of positive electricity, for instance; or gravity, in terms of positive and negative electricity" (p. 232).

The author of this book, however, starting merely with three postulates, (1) absolute energy, (2) æther, (3) some form of interaction between them, develops a theory which claims to admit of the main facts of natural phenomena being arranged "in a homogeneous and inter-related series." The fundamental (though by no means new) conception of the theory is that of the *gyron*. The author supposes all matter to be made up of little planetary systems composed in their last analysis of gyrons which are themselves simply æther in an extremely energetic state of motion. The gyrons and systems of gyrons are supposed to resemble small discs in rapid rotation about a central axis, and in consequence capable of giving rise to three entirely distinct types of æther motion or *force*. These are called (1) the Alpha force, (2) the Beta force, (3) the Gamma force. Gravity and cohesion are different forms of the Alpha force; X-rays, light and heat are forms of the Beta force; electric and magnetic forces come in the category of the Gamma force.

It is not very clear how the author arrives at the existence of these forces emanating from the gyron, but by means of them he is able to discuss the evolution of the atom, the relations of the elements, heat, light, electricity, dissociation. The "mystery of life" even is not excluded from the discussion.

The treatise, as the author himself frankly acknowledges, is a purely imaginative one, and we do not agree with him in thinking that the diverse and tentative views held just now by our leading investigators as to the ultimate constitution of matter afford a sufficient justification for the present attempt to explain matter and electricity by an effort of the imagination. Views and theories based on mathematical and experimental investigations are to us certainly more convincing.

*The Fossil Fishes of the Hawkesbury Series at St. Peter's.* By A. Smith Woodward, Mem. Geol. Surv. N. South Wales. (Sydney, 1908.)

Dr. Smith Woodward describes a series of Permo-Carboniferous fishes from St. Peter's, one of the Illawara suburbs of Sydney. The greater number of the specimens, including genera new to the Hawkesbury formation, were obtained from a dark indurated shale. The discovery of Sagenodus is interesting in connection with recent discoveries of dipnoan fishes in Australia, from the fact that we have evidence of the forerunners of the surviving Ceratodus in various formations from the Devonian to the Jurassic, and it is suggested that Ceratodus may have evolved in the Australian region. A new palæoniscid genus, Elpisopholis, allied to Phanerosteon and Sceletophorus, is described, in addition to several new species of fishes. A few specimens, somewhat newer in age, were obtained from a soft grey shale resembling that at Gosford. The work is well illustrated by four plates and a restoration of the new genus.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### Lamarck's "Système des Animaux sans Vertèbres."

This work, as is well known, was first published in the ninth year of the Republic, or 1801 A.D. (*i.e.* the last nine months thereof). But, to judge from the usual bibliographies and library catalogues, it does not appear to be generally known that the original sheets were re-issued with a fresh title-page in the following year. The differences between the two title-pages are quite unimportant until the imprint is reached. This in the first issue reads as follows:—

A PARIS

Chez { L'AUTEUR, au Muséum d'Hist. Naturelle; DETERVILLE, Libraire, rue du Battoir, nº 16, quartier de l'Odéon.

AN IX—1801.

In the second issue the imprint is:—

A PARIS

Chez { Maillard, Libraire, rue du Pont de Lodi, Nº 1. Deterville, Libraire, rue du Battoir, Nº 16, quartier de l'Odéon. Moulardier, Imprimeur-Libraire, quai des Augustins, Nº 28.

AN X—1802.

That this was a re-issue and not a new edition is proved by a copy in the possession of my friend Mr. Victor W. Lyon, city engineer of Jeffersonville, Indiana. The text and tables present absolutely no difference from those of the first issue, and the new title-page, instead of forming a part of the first section, has been printed on a wide fly-leaf, the inner margin of which is folded round the adjoining leaves of the first section.

This new title-page has some interest as suggesting that the work was taken up by the booksellers more warmly than had been anticipated, and that it was no longer necessary for the author to be at the trouble of selling his own copies.

Since the writings of many naturalists show that a confusion already exists in their minds between the "Système," 1801, and the "Histoire," 1815–22, it has seemed advisable to help them out of any fresh difficulty that might be presented by the existence of two dates for the "Système." Just now, when Lamarck is being specially commemorated, it may be thought worth while to publish this detail, which otherwise might be overlooked.

F. A. Bather.

September 5.

### The Hong Kong Typhoon of July 27 28.

This typhoon appears to have been very similar in size, direction, and intensity to that which caused such destruction in Hong Kong on September 18, 1906.

It was notified by both the Hong Kong and Manila observatories on July 26. It was then said to be in the Balintang Channel, which runs between Luzon, the northern island of the Philippines, and Formosa, and is about 500 (nautical) miles E.S.E. of Hong Kong; the observations available at that date showed it to be moving westwards, but were not sufficient to indicate that it was a storm of any great intensity. From the Balintang Channel it crossed some 500 miles of open sea without an observing station, and it was not until 6 p.m. on July 27 that the local indications were such as to cause the observatory officials in Hong Kong to hoist the signals indicating a typhoon within 300 miles of the colony. At 9.30 p.m. it was notified that the typhoon was moving towards the coast in the neighbourhood of Hong Kong. At 11.15 p.m. the signal was hoisted indicating that a typhoon was imminent. The barometer commenced to fall sharply at 10 p.m., and reached its minimum at 1 a.m. on July 28; the fall varied from half an inch to an inch in these three hours in different parts of the colony, the variation in the fall indicating that the typhoon centre passed close to the south of the island. The speed would seem to have been about normal. The typhoon was in the Balintang Channel on the morning of July 26, and the centre passed Hong Kong at 1 a.m. on July 28—500 miles in forty hours, or $12\frac{1}{2}$ miles an hour.

Owing to the timely warning, and to the gale coming from the east, in which direction the harbour is well sheltered, the damage to the shipping in it was comparatively small; four large steamers were driven ashore, a steel four-masted barque lost two of her masts, and many of the smaller craft suffered, with some loss of life, but the majority had acted on the warning given, and sought such shelter as was available. Outside the harbour the most serious disaster was the loss of a river steamer bound from Canton to Hong Kong, and with it some 400 lives. H.M. destroyer *Whiting* was also driven ashore and badly damaged. On shore the damage far exceeded that done by the typhoon of 1906. The damage to trees, most of which are evergreens, such as banyans, was such as almost entirely to deprive the roads and gardens on the lower levels of much needed shade. The roads were covered with broken branches, which will take weeks to remove. Even such hard-leaved plants as bamboos are, in exposed situations, now nothing but masses of stalks and withered yellow leaves.

The houses suffered mainly in their roofs and windows; the roofing used consists of the pantiles and mortar rolls common to China and the East, and is very liable to slip with the vibration caused by a hurricane. Several of the lower-class houses were demolished, with some loss of life. The gale commenced about 10 p.m. on July 27, and ended about 4 a.m. on July 28. Unfortunately, both the Kowloon Observatory anemometer and that at Victoria Peak, 1800 feet above sea-level, were damaged during the gale, and records are not available. It is thought that the force of the wind far exceeded that of the typhoon of 1906, and was very near to, if it did not exceed, the highest previous record of 108 miles per hour, in 1896.

Hong Kong, August 11.

L. Gibbs.

## THE GERMAN MUSEUM OF SCIENCE AND TECHNOLOGY.

THE guide[1] to the collections in the new German Museum at Munich shows that the examples of the Conservatoire des Arts et Métiers in Paris, and of the Machinery and Inventions Museum at South Kensington, have been successfully followed, and even improved upon, in the Bavarian capital. In the old National Museum in the Maximilianstrasse a remarkable collection of "Meisterwerken" of science and technology has been brought together in a few months, a collection which is well worthy to rank with those which are the results in Paris of a hundred years, and at South Kensington of fifty years, of strenuous work.

In Germany the scheme for such a museum was suggested on May 3, 1903, by Oscar von Miller. The idea was adopted with enthusiasm; and George Krauss, the eminent authority on the locomotive, was the first to show practical interest in the scheme by presenting the sum of 5000*l.* A site for the museum was granted by the municipality of Munich, and a temporary home was found in the old National Museum and in the Isar barracks. The aim of the museum is to illustrate the gradual historical development of scientific research and of technology by means of original apparatus and machines, and by means of a library of ancient and modern works. On September 20, 1906, thirty-one competitive designs for the new museum were received from German architects, and on October 20 the first prize was awarded to Gabriel von Seidl for his design for a building, the cost of which was estimated at 375,000*l.* For meeting this cost, the city of Munich voted 50,000*l.*, the Bavarian Government 100,000*l.*, and the German Imperial Government 100,000*l.* The greater part of the remainder has been subscribed by scientific and technical corporations and individuals. On November 13, the day of the opening of the temporary museum, the foundation-stone of the new building was laid by the Prince Regent of Bavaria in the presence of the German Emperor, and in a few years' time the collections will have a stately permanent home.

In the meantime the collections are admirably displayed in the temporary museum, and a mere enumeration of the classification of the contents of the fifty-six rooms will suffice to show the vast field covered. The classification (Fig. 1) is as follows:—1, geology; 2, mining; 3–6, metallurgy; 7, hydraulic motors; 8–9, steam engines; 10, land transport; 11–12, roads; 13–14, motors; 15, astronomy; 16, geodesy; 17, mathematics; 18, mechanics; 19–20, optics; 21, heat; 22–23, acoustics; 24–26, electricity; 27 telegraphy; 28, telephony; 29, drawing and painting; 30, writing and printing; 31, photography; 32 horology; 33–35, textile industries; 36–37, agriculture; 38, dairy work; 39, brewing and distilling; 40–45, chemistry; 46, hydraulic engineering; 47, inland navigation; 48, canals; 49–51, naval architecture; 53–55, library and plan collection; and 56, court of honour.

It is impossible in the space available even to enumerate the many objects of interest shown. Walking through the rooms in the order indicated, one notices the first geological map of Bavaria by Michel in 1768, Siemens's first electric mine locomotive (1881), a model showing the Ilgner system of electric winding in shafts (Fig. 2); a huge model, on a scale of one-twelfth the natural size, of Krupp's steelworks, with the 50-ton steam hammer, and near it an original village smithy of the nineteenth century, and the first cast-steel bell made by Jacob Mayer in 1854. Among the hydraulic motors there are an old Roumanian water-wheel, such as that described by Leonardo da Vinci, the prototype of the modern turbine; the first Fourneyron turbine; and the Reichenbach hydraulic engine, built in 1817, and used until 1904 for pumping brine from Berchtesgaden.

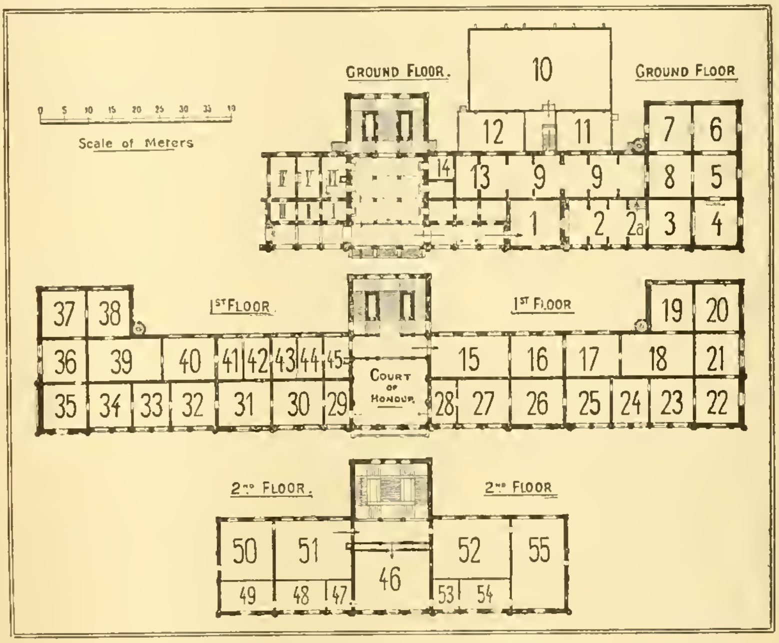



*Fig. 1. Plan of the German Museum.*

Among the steam engines one notices a model of the oldest German steam engine built for mine-drainage at Eisleben in 1813; the original water-tube boiler made by Alban in 1859; the original forms of Parsons' and De Laval's steam-turbines; and the first German portable engine built by Wolf in 1862. In Room 10 the development of land transport is shown. There are reproductions of the first bicycle and of the first motor-car, and an exact copy of Hedley's locomotive, "Puffing Billy," at South Kensington; a modern Bavarian express locomotive cut to show the internal construction, and, suspended above it, Lilienthal's flying machine.

On the first floor the physics division begins. A remarkable series of original instruments and models illustrates the development of astronomical work, and in succeeding rooms there are the original apparatus of Fraunhofer, Helmholtz, Kirchhoff and Bunsen, Ohm, Ampère and Röntgen, the originals of the first electric telegraph of Sömmerring (1809) and Reis's first telephone (1863), side by side with reproductions

[1] "Deutsches Museum von Meisterwerken der Naturwissenschaft und Technik." Führer durch die Sammlungen. Pp. 158; with 55 illustrations. (Leipzig: B. G. Teubner, 1908.) Price 1*s.*

of the apparatus of Otto von Guericke, Galileo and Volta. Passing on to the technological group, one notices the original lithographic press invented by Senefelder in 1797, and reproductions of Hargreaves's

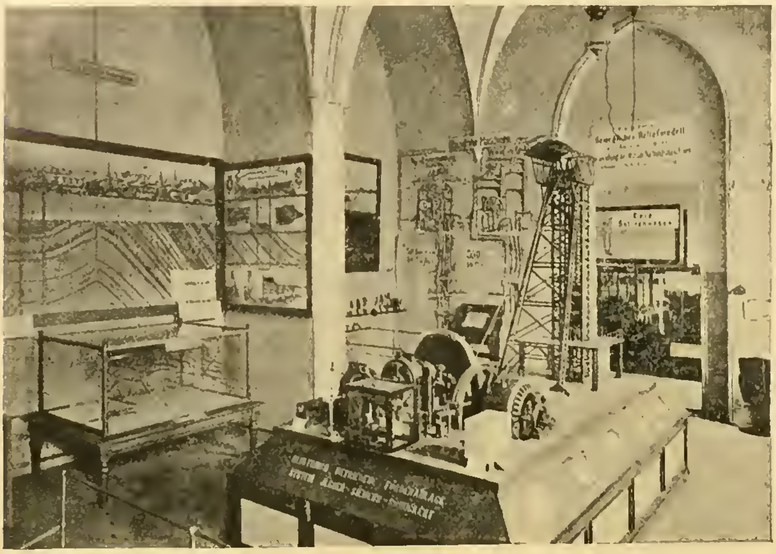


FIG. 2.—Model of electric winding plant.

spinning jenny and of the first Jacquard loom. The chemical section is of special interest. There are four completely equipped laboratories of different epochs—an alchemist's laboratory (Fig. 3), with portraits of Albertus Magnus, Paracelsus, Agricola, Van Helmont and other investigators of the sixteenth and seventeenth centuries; an eighteenth-century laboratory; Liebig's laboratory as installed at Giessen in 1839; and, lastly, a modern laboratory illustrating the latest developments of chemical apparatus.

The Court of Honour contains portraits in oils of Josef von Fraunhofer (1787–1826), K. F. Gauss (1777–1855), G. W. Leibniz (1646–1716), Otto von Guericke (1602–86), and Justus von Liebig (1803–75); and busts of Werner von Siemens (1816–92), Alfred Krupp (1812–87), Robert Mayer (1814–78), Hermann von Helmholtz (1821–94), Robert Bunsen (1811–99), and Henne Gensfleisch, known as Gutenberg (died 1468). There is also a collection of medals of scientific interest, including the Bessemer Gold Medal of the Iron and Steel Institute, and other medals awarded by British societies. Framed on the walls is a collection of historical documents, letters of Ampère, Berzelius, Faraday, Ohm and others. There is also a volume recording in chronological order the gifts received by the museum from all parts of the world.

The museum is keenly appreciated. The number of visitors averages 3000 on Sundays and 1000 on week-days. The detailed information given on the labels describing the objects has been compiled with scrupulous care, and adds greatly to the educational value of the collections. Huxley's definition of a museum was that it is a consultative library of objects. The German Museum is a consultative library for the engineer and the man of science, and it is something more. It is an effective agency for the enlightenment and education of the masses.

BENNETT H. BROUGH.

FIG. 3.—An alchemist's laboratory of the sixteenth century.

## THE NORTH-WEST PASSAGE.[1]

STRICTLY speaking, the north-west passage was accomplished in 1847, when Franklin and his men, retreating from their abandoned ships to the north-west of King William Land, passed through Simpson Strait to the mouth of the Great Fish River, and so crossed the tracks of Dease and Simpson, who in 1839 had reached Castor and Pollux Bay from the west. The existence of channels at least continuous, and possibly navigable, from east to west was thus proved. Later, in 1853, McClure and his men, abandoning the *Investigator* in Mercy Bay, Banks Land, which point she had reached from the Pacific, retreated to the ships of Belcher's squadron, then wintering on the south-east of Melville Island, and ultimately reached home. This was the first party to complete the traverse of the American Arctic regions from ocean to ocean. Technically, McClure did the north-west passage, but he proved at the same time that his route was quite impracticable. The *Enterprise* under Collinson, the *Investigator's* companion ship, did more towards the discovery of the passage by reaching Cambridge Bay from the west. Consequently, the only part untraversed by a ship was from the north of King William Land to

[1] "The North-West Passage." Being a Record of a Voyage of Exploration of the Ship *Gjöa*, 1903–7. By Roald Amundsen; with a Supplement by Lieut. Hansen. 2 vols. Pp. xiii+335 and pp. ix+397; illustrated. (London: A. Constable and Co., Ltd., 1908.) Price 31*s*. 6*d*. net.

the south of Victoria Land. A link of only some 200 miles (by the most direct channels) was all that remained to be forged when Amundsen planned and equipped his expedition in the *Gjöa*. But these facts cannot detract from the interest of the two volumes before us; the length of the *Gjöa's* voyage, no less than its historical importance, justifies the many pages.

There is no doubt that Amundsen's expedition will live in the annals of polar exploration in virtue of the accomplishment of the north-west passage; but that was only its secondary aim. "Our first and foremost task was to obtain exact data as to the Magnetic Pole," says Amundsen, and he repeats it several times. It had long been his ambition to navigate the north-west passage, but with a praiseworthy self-denial he compelled himself to keep the fulfilment of this feat of navigation subordinate to his scientific researches in magnetism. And yet in perusing the pages of the book one feels that the adventurous spirit of the Norseman was kept in check with difficulty; the desire to accomplish the passage was uppermost in his mind, and when once the greater part of the magnetic work was behind him his hearty enthusiasm seems to have been redoubled. However, in spite of this, Amundsen retained the *Gjöa* for nineteen months in winter quarters on the south-east of King William Land so that he could fulfil his programme of magnetic work, and this notwithstanding the fact that he saw open water ahead, and in all probability no obstacle in his road to the Pacific. That was an exhibition of devotion to scientific work in face of the greater fascination of an adventurous voyage which is most commendable and by no means common in polar exploration.

The *Gjöa*—a vessel of only forty-seven tons—left Christiania in 1903, and traversing Lancaster Sound and Barrow Strait reached Peel Sound. Amundsen was fortunate in finding Peel Sound open, as Franklin did in 1846 (but not so M'Clintock in 1858), and encountering no difficulties he sailed down Franklin Strait and entered Ross Strait to the east of King William Land. Here he was in virgin waters, for although M'Clintock had sledged down this strait in 1858, the *Erebus* and the *Terror* had passed to the west of King William Land in ignorance that there was a passage to the east. It was Rae who discovered the insularity of that land, and he held the opinion —afterwards shared by M'Clintock—that the only navigable passage was along its eastern and southern coasts. The ice pressing southward through Victoria Strait, narrow and encumbered with islands as it is, must always prove as insuperable an obstacle as it did to the *Erebus* and the *Terror*. Amundsen had reason to congratulate himself on following Rae's advice in this matter. Passing along Rae Strait the *Gjöa* went into winter quarters in September in a snug little harbour on the south-east of King William Land, since christened Gjöa Haven. The situation admirably suited the requirements of the work, which, the author explains, demanded such a distance from the magnetic pole that the inclination would be about 89°. From this base frequent excursions were made in all directions, Amundsen himself sledging on one occasion northward as far as the locality of the magnetic pole in Boothia Felix. By his observations he proved the truth of the theory that the magnetic pole has not a stationary position, but, on the contrary, is in continual movement within certain limits.

During April, May, and June, 1905, Lieutenant Hansen, accompanied by Ristvedt, made a sledge journey to Victoria Land, and succeeded in charting, as far as 72° N., the western shores of M'Clintock Channel, the supposed breadth of which he found had been much exaggerated. The new coast was named King Haakon VII. Coast. In addition, the "land seen by Rae" in Victoria Strait, which proved to be a group of many islands, was charted, though the work seems to have been done somewhat roughly. These surveys included all the topographical work of the expedition; nowhere else did the explorers touch quite new land. In August, 1905, the westward journey was resumed, and after some tortuous navigation through an island group in the north of Queen Maud Sea, Cambridge Bay was reached—the "farthest east" of Collinson's *Enterprise*. Thence onwards until King Point was made navigation was relatively simple, but at that point the *Gjöa* was stopped by ice, and compelled to pass a third winter. In the summer following she reached Nome City, and ultimately San Francisco, where she now lies, waiting, we understand, for the completion of the Panama Canal to return to Europe.

Fig. 1.—King Point. Shore strewn with Driftwood. From "The North-West Passage."

Amundsen thus accomplished the north-west passage, and, moreover, found a route that would probably be practicable for a small ship in any year if only Franklin Strait could once be reached from the east. The greatest difficulty in the whole passage lies in entering Franklin Strait, for Peel Sound and Bellot Strait, both of which Amundsen found open, may just as likely be blocked with pack-ice, as M'Clintock found them. Neither Ross nor Rae Straits appear to give much trouble, though in thick weather navigation in the vicinity of the magnetic pole must be, as the *Gjöa* found it, somewhat hazardous. The Esquimaux insist that Simpson Strait breaks up every year, and while Queen Maud

Sea probably is seldom navigable, the passage through Palander or Markham Straits, though intricate, is possible; three fathoms was the shoalest water found.

Except for the work in Victoria Strait and M'Clintock Channel, the voyage can scarcely be called one of exploration. The greater part of the route was relatively well known and charted. The expedition was never absolutely out of touch with the civilised world. Even at King William Land they got a mail by Esquimaux from Cape Fullerton, Hudson Bay, while at King Point they were in the company of whalers, missionaries, and policemen. During that winter Amundsen made a journey to Eagle City to get into cable communication with Europe. The main scientific work, magnetism, was successfully carried out, and a good series of meteorological observations were taken, at least in winter quarters. Lindström, the cook, was an enthusiastic collector of plants and animals, but, though one of the party was a geologist, we do not gather that geological observations and collections were made, except a few fossils at Boothia Felix and King William Land. That is a pity in view of the many opportunities that must have occurred during a voyage practically always within touch of land. Nor do we gather that any soundings were taken other than those essential for the navigation of the *Gjöa*; certainly none are indicated on the outline maps which accompany the volume. However, with regard to the Esquimaux encountered, very full information is given. The first two winters were passed in the company of the little-known Nechilli tribe. They appear to be one of the few tribes of Esquimaux who fortunately have had little or no contact with white men, though it was from members of this tribe that Rae got the news of Franklin's fate.

Amundsen tells his story in a lucid, interesting style, and, though the book would not lose by condensation in places, it is singularly free from the trivialities with which such volumes are often loaded. But an appendix of scientific results would have given more permanent value to these volumes.

One rather serious error on p. 59 should be mentioned. The author speaks of passing through Bellot Strait when he evidently only passed by the end of it.

A very full and accurate index is provided.

FIG. 2.—A Eskimo Camp in Winter Time. (Photograph taken at midnight.) From "The North-West Passage.

## THE REPORT OF THE ROYAL COMMISSION ON THE CARE AND CONTROL OF THE FEEBLE-MINDED.

TO whatever criticisms this report may be subjected it cannot truthfully be characterised as either pusillanimous or incomplete. It is to the credit of the members of the commission that they have searched so thoroughly for their data and so fearlessly faced the numerous difficulties which the evidence presented to them. As a whole the report is broad-minded, eminently practical in its adjustment to the necessities of the situation, and conceived at once in a humanitarian and utilitarian spirit. Whether it is in advance of national ideas remains to be seen by the manner in which the legislature is prepared to deal with it.

The report necessarily opens up matter of great scientific interest; but the commissioners, perhaps wisely, have contented themselves with deducing from a mass of scientific evidence only such conclusions as bear upon the practical issues under their consideration. On the momentous question of the origin of mental defect, they remark somewhat plaintively (vol. viii., p. 179), "we found it practically impossible, and deemed it undesirable, to exclude from consideration the great mass of evidence which was tendered to us in reference to the conditions and antecedents of mental defect, especially in the very large class of cases in which the evil dated from birth or from early life." The great majority of the witnesses who spoke specially on this question (among whom were Sir T. Clifford Allbutt, Sir E. Ray Lankester, Dr. Archdall Reid, and Dr. Bevan Lewis) regarded feeble-mindedness (where not accidental) as a germinal variation, a reversion to a more primitive type of brain, and a condition which is necessarily inherited. The trend of the evidence of these witnesses was distinctly opposed to the notion that causes such as faulty nutrition, wasting diseases, or alcoholism are of importance in the production of feeble-mindedness. Considerable evidence of a contrary kind was offered, but neither the authority of the witnesses nor the data upon which they relied was sufficient to shake what is at present the accepted teaching of biology. As might have been expected, an attempt was made by certain witnesses to put forward the opinion that the existence of mental defect in a community might be checked either by surgical or other artificial measures, or by placing obstacles in the way of the marriage of persons ascertained to be mentally defective. The commissioners repudiate these suggestions, but they nevertheless somewhat hesitatingly come to the conclusion upon the evidence submitted (vol. viii., p. 185), "(2) that especially in view of the evidence concerning fertility, the prevention of mentally defective persons from becoming parents would tend largely to diminish the number of such persons in the population." This is an opinion on which there is much room both for doubt and discussion. Many of the feeble-minded are the children of parents of average physical and mental health; a still larger number are children of neurotic parents, who are, however, of such mental integrity that no State would venture to prohibit their unions. The number of the feeble-minded who are descendants of obviously imbecile parents, while probably not inconsiderable, does not by any means form such a proportion of the class that the prevention of their existence would "largely" diminish the number. If mental unsoundness were a foreign strain introduced into a community, then it might possibly be extirpated in one of the several ways suggested; but as it is a germinal variation which, so long as individuals are not at a dead-level of mental endowment, must always arise anew, it is useless to propose means, adaptable to civilised societies, for checking its production. The alleged fertility of the feeble-minded referred to in the above quotation is contrary to general experience, which has hitherto rather pointed to an increasing sterility in direct ratio to the degree of the existing mental degeneracy. The existence of a special degree of fecundity on the part of the parents of the feeble-minded would require much fuller and more accurate statistical proof than has been produced by the promoters of the statement. The generally accepted view is that the more pronounced the feeble-mindedness the less fertile is the individual, and conversely, that the less feeble-minded the individual the more fertile he is likely to be. But feeble-mindedness is a term including a variety of mental conditions; on the one hand it embraces the absolute idiot, and on the other merges insensibly into the average mental level of the community. The attempt to prevent the union of the higher grades of the feeble-minded, who are also the most fertile, would thus be manifestly futile. The commissioners are, however, on safer ground when they suggest that some prevention in this respect is likely to be effected from the seclusion of the numbers of the feeble-minded with which their far-reaching recommendations propose to deal, for they say (*loc. cit.*) "(3) that the evidence strongly supports measures, which on other grounds are of pressing importance, for placing mentally defective persons, men and women, who are living at large and uncontrolled, in institutions where they will be employed and detained; and in this, and in other ways, kept under effectual supervision so long as may be necessary."

At p. 193 (vol. viii.) of the report a tabulated estimate of mentally defective persons (excluding certified lunatics) in England and Wales is given. From it may be seen that out of 149,628 such persons 66,509, or 44·4 per cent. of the whole, are practically unprovided for. The following abstract from the table is of interest:—

| | Number | Feeble-minded | "Needing provision." |
|---|---|---|---|
| School children ... ... | 6,044,394 | 47,515 | 35,804 |
| Paupers— | | | |
| (1) Indoor ... ... ... | 229,804 | 41,793 | 6,990 |
| (2) Outdoor .. ... | 532,778 | 12,308 | 4,790 |
| Prisoners ... ... ... | 21,221 | 1,942 | 1,608 |
| Inebriates in reformatories | 970 | 582 | — |
| Persons mostly under no public authority ... | 25,576,697 | 45,488 | 17,317 |
| | 32,405,864[1] | 149,628 | 66,509 |

These figures amply justify the grave statement in the introduction to the report (p. 9), "there are numbers of mentally defective persons whose training is neglected, over whom no sufficient control is exercised, and whose wayward and irresponsible lives are productive of crime and misery, of much injury and mischief to themselves and to others, and of much continuous expenditure wasteful to the community and to individual families."

It is evident that the crux of the situation lies in the education and after care of feeble-minded children, 75 per cent. of whom are not only neglected in youth, but are more or less lost sight of in adult life. As means towards remedying these defects the recommendations of the commissioners appear sufficiently comprehensive. County councils or burgh county councils, as the case may be, are to be under statutory obligation to provide for the manual, industrial, or other training of mentally defective children who are not otherwise properly provided for; specially qualified medical officers of these bodies are to examine and report upon all such children, and, in case of doubt as to whether a child is mentally defective or merely "backward," the child may be placed upon a special probationary list and retained for such a period as may be considered necessary in a special class, school, institution or home for the mentally defective. Further, in the case of feeble-minded persons under twenty-one years of age who are not receiving suitable training, or are being cruelly treated or otherwise neglected, the local authority may, on the recommendation of their medical officer, assume all the rights of a parent or guardian until the child ceases to be a minor, subject to an appeal by the parents or guardians to a court of law. In the case of a person of feeble mind more than twenty-one years who is not suitably provided for, the local authority may, if it considers it necessary, present a petition as next friend of the mentally defective person with a view to his detention, control, or proper care.

Such, in brief, are the means suggested for the selection, registration, education, care, and, where necessary, the permanent control of the feeble-minded. Were these recommendations to become law there is good ground for believing that in course of time much social sordidness, petty delinquency, and domestic misery would be checked at its source. Under existing administrative conditions it is well known to be

[1] General population other than certified lunatics, &c.

initiated—and the testimony of many witnesses who gave evidence before this commission gives the fact publicity—that vagrancy, prostitution, petty delinquency, pauperism, and inebriety are the pitfalls into which numbers of the poorer and less protected feeble-minded ultimately stumble.

Mentally defective children do not, however, by any means exhaust the category of persons requiring to be dealt with in any scheme of reform aiming at comprehensiveness. In illustration let us take the question of delinquency. Among feeble-minded delinquents two classes may be distinguished:—(1) Intellectually feeble persons in whom the moral sense is either practically wanting or so imperfectly developed as to afford no guide for conduct. (2) Those in whom the intellectual faculties are of average development, but who are either morally perverted or who possess such feeble moral resistance when the mind is crossed by certain emotional currents as to be practically irresponsible. Now it is evident that persons of the second class may up to adult age evade all ordinary tests applied for the detection of feeble-mindedness and afterwards manifest by their conduct such persistent moral obliquity as to raise the question of their mental responsibility. Many such persons pass most of their time in gaol as short-sentence prisoners, repeatedly convicted week after week on account of drunkenness, breaches of the peace, pilfering, &c. It may be that most of them are inebriates, but they are, in addition, weak-minded, irritable, profligate, and lacking in self-control in other directions than indulgence in alcohol. The entire uselessness of these repeated convictions is apparent, and the expenditure of money upon police, judicial procedure, and maintenance in prison must necessarily be greater than if these individuals, in accordance with the recommendations of the commissioners, were committed to homes or colonies on indeterminate sentences, where they might, to a certain limited extent, at any rate, be partially self-supporting. The recommendations in the report would make it obligatory upon the police and prison authorities to report such cases to the local authority, and upon the medical officer of the latter to act upon such reports.

In order that such notification may be of practical utility, it is necessary to reform the procedure under the various criminal lunacy acts. To this end the commissioners recommend that when a court of summary jurisdiction is of opinion that a person charged is mentally defective the court may (1) remand the person charged to a receiving house or institution for observation, or (2) make out a summary order for the reception of such a person into an institution on the certificate of the medical officer, or (3) after conviction may hand him over to the care of an officer of the local authority who becomes surety for his conduct. Such a person would remain under the care of the local authority until it sees fit to discharge him. Similarly in assize and quarter sessions' cases the justices may hand a feeble-minded prisoner over to the local authority pending trial; or when brought to trial the court may direct that the accused be submitted to examination, and, if necessary, certification, notwithstanding that he has been acquitted of the offence charged, if it is considered desirable that provision should be made for his care.

The analysis of the various types of the mentally defective, with their peculiarities and special dangers and inconveniences to society, and the many suggestions in the report for dealing with them, might be indefinitely prolonged and criticised, but sufficient has been said to indicate the wide scope of the field traversed by the commissioners. It remains to examine cursorily the machinery which the commission proposes for carrying out its recommendations. With logical consistence it urges that one central authority in each of the three kingdoms should have the control of all the mentally afflicted, and that that authority should be the existing lunacy commissions, enlarged and suitably equipped for the purpose. The advantage of having one central authority to supervise the care of all classes of the insane is apparent, and the withdrawal of certain classes of the insane from the control of such departments as Education and Local Government, where official interests are necessarily directed into totally different channels, needs no apology. Moreover, experience amply shows that progress in scientific and administrative knowledge is best attained when those at the head of any such department have at any rate such interest in its welfare as to encourage scientific pursuit in connection with it. With equal wisdom it recommends the utilisation of existing local authorities—in England and Ireland a statutory committee of county councils or borough councils, as the case may be, and in Scotland the district lunacy board. These local authorities shall, subject to the supervision of the central authority, have the entire control of all insane, feeble-minded, or mentally affected persons within their jurisdiction who are not otherwise adequately cared for privately, and it shall be their duty to provide such accommodation as is suitable to the various classes, *e.g.* asylums for the insane, training schools for imbeciles, colonies or private homes for the mentally enfeebled, &c.

A question of great importance both in its bearing on the liberty of the subject and the proper inclusion of every class of the mentally afflicted within the scope of the proposed measure is the form of the medical certificate prescribed.

The commissioners recommend that the word "lunatic" in the ordinary medical certificate be deleted and replaced by the words "mentally defective person." So far as comprehensiveness goes this is admirable. Whether it is a sufficiently accurate term to merit universal acceptance is another matter. There will, however, be general agreement with the resolution that the word "lunatic" shall be henceforth discontinued as a descriptive term, that "asylums" shall be called "hospitals," that the Board of Commissioners in Lunacy shall be called "The Board of Control," and that the term "mentally defective" shall be defined in the proposed Act as comprising "persons of unsound mind," mentally infirm persons, idiots, imbeciles, feeble-minded persons, moral imbeciles, epileptics, and inebriates who are mentally affected, and deaf, dumb, or blind persons who are also mentally affected. It is only by such a radical change in nomenclature that the object of including all these classes in one legal category could be attained, though the definite term suggested may not, as has been hinted, be the most appropriate.

With regard to the financial aspect of the proposed scheme, it will probably be much more formidable than the estimate given by the commissioners on p. 295 of the eighth volume of the report. Against the danger of any excessive financial burden being laid upon the country as the result of an Act, based upon the report, becoming law, it must be borne in mind that the great majority of the mentally unsound in the country are already under care—more or less perfect, and more or less expensive. The transference of those already under care from one form of administrative control to another ought not to entail any great additional expenditure; but the cost of the more perfect provision for some 60,000 feeble-minded persons in England alone is an item which cannot be lightly entertained. If, however, the other side of the account—the social dilapidation and degradation, the useless penal measures, the illegitimacy, and the pauperism with which such persons already burden the ratepayer—is kept in view, it is doubtful if the expense of their maintenance in decent surroundings can much exceed the wastage resulting from their present condition of so-called freedom.

## NOTES.

At the meeting of the Paris Academy of Sciences on Monday last a letter was read from M. Jean Becquerel stating that his father, the late M. Henri Becquerel, had left the sum of 100,000 francs to the academy in the following terms:—"I bequeath to the Academy of Sciences the sum of 100,000 francs (4000*l.*) in memory of my grandfather and father, who were, like myself, members of your academy. I leave to it the responsibility of determining the best use which it can make of the interest on this capital, whether by creating an endowment or prize, or by distributing this income in a manner calculated to encourage the progress of science."

Colonel Sir David Bruce, C.B., F.R.S., accompanied by Captains H. R. Bateman and A. E. Hamerton, Sergeant A. Gibbons and Mr. James Wilson, is about to sail for Uganda to investigate further the pathology of sleeping sickness. On arriving at Mombasa, the commission will travel by the Uganda Railway to the terminus at Port Florence, whence the lake will be crossed to Kampala. The headquarters of the work will be selected two miles from the lake shore in a wild and depopulated region in the province of Chagwe. Here the Uganda Government has been preparing a laboratory and station for the purposes of the mission. It is expected that the work will occupy about nine months.

A Reuter telegram from Simla, dated September 14, states that Dr. Sven Hedin has arrived at Fagu, twelve miles from Simla, in excellent health. During his travels he has been quite isolated in the wilds, and saw no white face until he reached Poo, in September, 1907, where the Moravian Mission offered him hospitality. Dr. Sven Hedin has, it is stated, travelled more than 4000 miles, mainly in western Tibet, and has made some noteworthy discoveries, regarding which he is very reticent for the present. He made extensive geological maps during his journey, the cost of which he estimates at more than 5000*l.* Dr. Hedin intends halting at Simla for ten days, and will then proceed direct to Sweden, and thence to London, where he has been invited to lecture by the Royal Geographical Society.

Since the time of going to press with our last number several successful flights have been made in America by Mr. Orville Wright in his aëroplane, the records of M. Delagrange and other competitors being easily beaten. On the morning of September 9 he stayed in the air 57m. 31s., and later in the day he flew for 1h. 2m. 15s., while on September 10 and 11 respectively he made new "world's records" by flying for 1h. 5m. 52s. and for 1h. 10m. 24s. On September 12 he was accompanied by Major George Squier, the acting chief signal officer, as a passenger, and remained in the air for 9m. 6s., flying at a speed of thirty-eight miles per hour. Major Gross, in the German military airship, made a circular tour on September 11 from Tegel, by way of Rathenow and Stendal, to Magdeburg, and thence back to Berlin, the trip lasting 13h. 2m. The previous longest flight—that of the *Zeppelin IV.*—lasted, it will be remembered, 11h. 50m.

The death is announced, at the age of sixty-eight years, of Mr. John T. Taylor, I.S.O., for many years assistant-secretary to the principal librarian of the British Museum. Mr. Taylor superintended the arrangements for the removal of the natural history collections to South Kensington, and was on special service at the Natural History Museum from 1880–4.

By the death on September 2 of Dr. Theodor Peters, the Society of German Engineers has lost its director. During the greater part of his connection with the society, extending over a period of twenty-five years, Dr. Peters was identified with all the changes made in the important institute under his guidance, and notably with the improvement and augmentation of the journal, the *Zeitschrift des Vereines deutscher Ingenieure*, the prosecution of systematic researches on points of mechanical and engineering interest, and the publication of such reports, not only in the current numbers of the journal, but as independent pamphlets, making the results accessible at merely nominal cost.

The Huxley lecture of the Charing Cross Hospital Medical College, on "Recent Advances in Science and their Bearing on Medicine and Surgery," will be delivered on October 1 by Sir Patrick Manson, K.C.M.G., F.R.S.

The medals, prizes, &c., will be distributed to the successful students of the Imperial College of Science and Technology, South Kensington, on Wednesday, October 7, by Sir William H. White, K.C.B., F.R.S. The rector, Dr. Henry T. Bovey, F.R.S., will deliver an address.

The third International Congress for the Care of the Insane will be held on October 7–11 at Vienna. The subjects to be brought under consideration will be divided up into nine sections as follow:—(1) collective descriptions of the present state of the care of the insane in different countries; (2) the medical treatment of the insane; (3) provision for the insane from the building or architectural point of view; (4) administration; (5) insanity and insurance; (6) comparative lunacy law; (7) the care of idiots, epileptics, and the feeble-minded; (8) report of the International Committee upon the proposed establishment of an international institution for the study of the causes of insanity; and (9) the insane in the army.

The eighth Australian Medical Congress will meet in Melbourne on October 17–24 next.

The third International Congress of School Hygiene is to be held in Paris from March 29 to April 2, 1910. In connection with it there is to be an exhibition of everything concerned with school hygiene. Information respecting the congress can be obtained from M. Dinet, 11 bis Rue Cernuschi, Paris, but inquiries concerning the exhibition should be addressed to M. Friedel, Musée Pedagogique, 41 Rue Gay-Lussac, Paris.

An International Industrial Exhibition is to be held at Turin from April to October, 1911, and will be divided into the following sections:—education, mechanics, electricity, photography, colonisation, national defences, measuring instruments and apparatus, public works, transportation (railways and tramways), mercantile navigation (sea, river, and lake), aërial navigation, postal services, sporting industries, modern town (dwelling, decoration, furniture), agricultural and forest industries, food industries and products, wearing apparel and leather industries, jewellery, printing, &c.

In addition to the papers announced for reading at the autumn meeting of the Iron and Steel Institute (see Nature, August 27, p. 398), a paper will be read by Mr. William Hawdon on the progress in the Cleveland iron and steel industries during the past quarter of a century, that is, since the previous visit of the institute to Middlesbrough in 1883. The paper promised by Messrs. J. E. Stead and T. Westgarth is to be held over until the next meeting.

Prof. von Leyden, of Berlin, and Prof. Czerny, of Heidelberg, have been elected, respectively, honorary president and president of the International Association for the Investigation of Cancer, which was founded at Berlin in May last.

According to the *Lancet*, Prof. Krämer, senior staff-surgeon in the German Navy, has been appointed to the charge of the scientific expedition now being fitted out for the Antarctic Ocean.

The publication of a monthly bulletin intended for the information of local health authorities and others interested in public-health work, and to keep them in touch with what is going on at headquarters, and in Western Australia as a whole, has been begun by the Department of State Medicine and Public Health of Western Australia. The body immediately responsible for its publication is the Central Board of Health, the president of which is Dr. T. D. Lovegrove.

To mark the completion of the fiftieth year of the existence of the Geologists' Association, it is proposed to issue a volume dealing with the geology of the districts of England and Wales visited by the association since its foundation. The work, which will be edited by Messrs. H. W. Monckton and R. S. Herries, will be illustrated by maps and sections, and be ready for publication, it is hoped, before the end of the present year. Orders for copies should be sent to the secretary of the association.

According to information received from Copenhagen, experiments in high-speed wireless telegraphy have recently been carried out by Mr. Poulsen, the Danish engineer. The experiments, which were conducted between the stations at Lyngby, near Copenhagen, and Esbjerg, on the west coast of Jutland, are declared to have resulted in the transmission of about 100 words per minute, and the inventor calculates that he will soon succeed in telegraphing 150 words a minute. It is added that the trials will, in the immediate future, be continued between Lyngby and Tynemouth, and new stations are being erected on the west coast of Ireland and in Canada, between which the high-speed system is to be employed.

The recently issued report of the chief sanitary officer of Cuba regarding the destruction of the mosquito in the island is most encouraging. The town of Palmira, where yellow fever occurred as lately as January of this year, has been so thoroughly cleaned that in a recent inspection not a single deposit of larvæ was found in 112 houses examined. Similar good results have been secured in other provinces. In zones once noted for the prevalence of yellow fever the Stegomyiæ have been reduced below the yellow-fever limit. In Havana mosquito breeding is practically at an end, as a breeding place was found in only one house in 450 inspected, and of these considerably less than one-half were found to be Stegomyiæ.

According to the annual report for 1907, a radical change has been inaugurated in the administration of the Marine Biological Association for the West of Scotland, and financial matters have, it is hoped, been placed on a more satisfactory footing. The committee has also expressed its intention of running the institution on strictly scientific lines, the systematic survey of the Clyde area being one of the first subjects for investigation.

The summer of 1908 will, we learn from the September number of the *Entomologists' Monthly Magazine*, stand as a good year for clouded yellows, this being the first season since 1904 that this erratic butterfly has made its appearance in considerable numbers in the Isle of Sheppey. Most of the specimens taken were males, and all were in fine condition and colour. Pale clouded yellows have not been seen in Sheppey since 1902.

In the *Irish Naturalist* for September Prof. G. H. Carpenter records two species of spring-tails (Collembola) as new to the British fauna. One of these was observed on a crop of tobacco, the cultivation of which has probably led to a great increase in the numbers of these minute insects. In the same issue a small gephyrean worm (*Petalostoma minutum*), typically from the Normandy coast, has been added to the Irish fauna. In No. 15 of the first volume of Economic Proceedings of the Royal Dublin Society (may we venture to call this a distinctly Hibernian title?) Prof. Carpenter gives an account of the injurious insects, &c., observed in Ireland during 1907. The fact of the caterpillar of the common rustic moth (*Apamea didyma*) feeding within the sheath-leaves of oats and barley appears to constitute a new record. A saw-fly (*Nematus maculiger*), hitherto known as feeding—in the larval state—on willow, has been detected in Ireland on larch, but beyond this there is little in the way of novelty in the year's account.

The *Museums Journal* for August contains an editorial article on recent correspondence in connection with the British Museum (Natural History), and the deputation to the Prime Minister on the same subject. The author of the article shares Mr. Asquith's inability to realise the shortcomings of the Museum referred to by the deputation, and adds that an inquiry into the working of that institution is not likely to be granted so long as criticism is based on purely theoretical considerations. It is suggested, however, that the trustees should include more men with a practical knowledge of museum work. "Eminence in certain branches of natural science," it is added, "does not necessarily fit a man to govern a great museum any more than does eminence in law or in theology."

Christopher Merrett (1614–1695) forms the subject of the third part of "Early British Ornithologists," which appears in the September number of *British Birds*. Merrett, it appears, was the author of a work entitled "Pinax [= a list, or index] Rerum . . . Britannicarum," published in London in 1666, which contains a list of the birds of the country. Although extremely meagre, this list was the first attempt of its kind published.

In *Biologisches Centralblatt* of August 15 Mr. O. Lehmann brings to a conclusion his interesting account of "scheinbar lebende Kristalle," in which he claims to have observed representatives of pseudopodia, cilia, and muscles.

It was reported by the Departmental Committee on Irish Forestry that the amount of land in Ireland available for forestry purposes is much less than is generally supposed. This is explained by Mr. A. C. Forbes in an article communicated to *Irish Gardening* (September). He advocates the establishment of nurseries by county councils to grow trees suitable for road-side planting, and for supply to farmers, who may be encouraged to help towards increasing the timber area in the country.

It is more than ten years since the disease known as root disease of sugar-cane was referred to the basidiomycetous fungus *Marasmius sacchari*; the fungus has been identified in the West Indies, Hawaii, and Java. Although various mycologists have had the subject under investigation, there is still a good deal to be learnt with regard to its growth and the best methods of prevention. Mr. F. E. Stockdale has rendered useful service in collecting available information in a paper published in the West Indian Bulletin (vol. ix., No. 2). He expresses the opinion that there is a reasonable possibility of checking the disease by the application of Bordeaux mixture and lime, and refers to the resistant property manifested by some of the West Indian seedling canes.

The Circular (vol. iv., No. 9) prepared by Mr. H. F. Macmillan, and issued from the Royal Botanic Gardens, Ceylon, on the acclimatisation of plants, offers several points for reflection. It furnishes evidence that the inhabitants of tropical countries, as much as of countries in temperate latitudes, have derived the greater part of their edible and economic products from exotic plants. Tea, coffee, cacao, rubber of all kinds, pine-apples, mangoes, and oranges have all been introduced into Ceylon; even the cocoa-nut palm, although of uncertain origin, is not indigenous. The author also differentiates between naturalised and acclimatised plants, and makes the broad generalisation that plants in which the reproductive period is normally prolonged are more easily acclimatised. The circular contains lists of acclimatised plants in Ceylon, naturalised weeds, and naturalised plants that have not become pests.

A remarkable form of copper-rod currency, known to the natives of the north-east Transvaal as Marali, is described in the August number of *Man* by Dr. A. C. Haddon and Mr. H. D. Hemsworth, of which only two specimens are believed to have reached this country. Each example consists of a straight rod of copper about 49 cm. in length, with an average diameter of 13 mm. One end is attached to the rounded apex of a flattened, oval, conical projection, the plane of which is set at a little more than a right angle to that of the rod. Peculiar markings on one specimen seem to indicate that the bore used for the casting was made by covering a reed with earth, and that in this case, the reed having split, the coppersmith had enveloped it with bands to keep it in its proper shape. This form of currency was used chiefly in the purchase of brides by the chiefs, and each rod seems at one time to have represented the value of ten cows, the ordinary exchange price of a wife. Similar rods, which Mr. G. W. Stow in his "Native Races of South Africa" (p. 518) was inclined to regard as Madulas or phallic charms, appear to be examples of this remarkable form of currency.

In the *National Geographic Magazine* for August Mr. T. Balfour contributes an account of the natives of Humboldt Bay, in Dutch territory, on the northern coast of New Guinea. Ethnologists will be interested in his description of their sacred drums and flutes, the latter so long that when "two men each takes one of these instruments and stand opposite each other, they blow into the end of the bamboo, and the length runs out so far that each man straddles his partner's flute." Their temples are taboo to women, and Mrs. Balfour experienced much difficulty in securing entrance and a sight of the sacred objects. The architecture is peculiar, the building consisting, as it were, of three cones superimposed one upon another, that at the summit being the smallest. Their modes of disposal of the dead range from desiccation to inhumation. The pestilential climate and the unfriendliness of the people offer little encouragement to the explorer of this portion of the island.

The August number of the Bulletin of the American Geographical Society contains an interesting article, by Mr. J. D. Hague, on the discoveries of Sir Francis Drake, accompanied by reproductions of the Drake commemoration medal recently issued by the American Numismatic Society—the third of the series, the two earlier ones being, respectively, one in honour of Americus Vespucius, issued in 1905, and one in memory of John Paul Jones, issued in 1906. The medal now referred to represents a bust portrait of Sir Francis, which Prof. Rudolph Marschall, of Vienna, with the aid of photographic copies taken specially for this work, by the courtesy of Lady Drake, has produced from an oil painting from life by Abraham Janssens, continuously in the possession of the family, and now at Buckland Abbey, Devon. The reverse of the medal is a reproduction, as a partial facsimile, of one side (the western or Pacific hemisphere) of the celebrated silver medal or "map of the world," which is generally believed to have been made shortly, or, at most, within a few years, after Drake's return from his "world-encompassing" expedition, and concerning which the late Sir John Evans wrote in terms of high praise when directing the attention of the Royal Numismatic Society to it.

An interesting note on the history of the knowledge of steel has been published in the *Revue de Métallurgie* (vol. v., No. 1) by Dr. Carl Benedicks, of Upsala University, the recipient this year of the Iron and Steel Institute's Carnegie gold medal for research. The difference between wrought iron, steel and cast iron, the varying proportion of carbon, was first demonstrated by Torbern Bergman in 1781. Linnæus (Pluto svecicus, 1734) describes steel as iron without sulphur, and the views adopted at that epoch were (1) that steel contained less "sulphur" than iron (Rohault and Polhem, 1740), and (2) that steel contained more "sulphur" than iron (Cramer, Gellert, Macquer, von Justi, Spielmann). The term sulphur at that period included all inflammable matter, such as asphalt and coal. The author directs attention to a forgotten French work, published anonymously in 1737, under the title of "Traité sur l'Acier d'Alsace, on l'Art de convertir le Fer de Fonte en Acier" (Strassburg). The writer of this work was an elder brother of Gilles Augustin Bazin, a Strassburg physician. Like Réaumur, he rejects the view that steel is purer than ordinary iron, and realises that steel must be made by adding a certain quantity of extraneous matter to wrought iron, or by removing foreign matter from pig iron. He had an exceptional knowledge of steel and of its thermal treatment, and his book deserves a place beside the monumental works of Réaumur and Swedenborg (1753). A Swedish translation of Bazin's book was published at Stockholm in 1753.

A short note on the study of sea-quakes in the Mediterranean, by Prof. G. Platania, of the R. Istituto Nautico, Catania, appears in the August number of the *Rivista Maritima*. Prof. Platania proposes to undertake an exhaustive study of this subject, and appeals for information and records.

The *Rendiconti* of the Reale Istituto Lombardo, vol. xli., contain a paper by Dr. Gorini on lactic acid fermentations of milk (fasc. xiii.), and one by Prof. Bordoni-Uffreduzi on diphtheria (fasc. xiv.–xvi.). In this it is shown that since the introduction of antitoxin treatment the number of cases of diphtheria in Milan has fallen from 1053, with 330 deaths, in 1896, to 657 cases, with 85 deaths, in 1907, a diminution of mortality per 10,000 living from 7·3 to 1·5.

THE *Atti della Fondazione Scientifica Cagnola* (xxi.) contains the reports of committees appointed to consider the merits of various prize essays submitted. The remainder (and greater part) of the volume contains an elaborate essay, by Dr. Moschini, on the supra-renal capsules, accompanied with a bibliography of fifty-five pages, and illustrated with some excellent coloured plates and tracings.

## OUR ASTRONOMICAL COLUMN.

COMET 1908*c*.—A set of elements and an ephemeris for comet 1908*c* have been computed by Herr H. Kobold, from observations made at Rome on September 3 and at Copenhagen on September 4 and 5, and are published in a supplement to No. 4272 of the *Astronomische Nachrichten* (September 4). The following are taken therefrom :—

*Elements.*

T = 1908 December 24·3175 M.T. Berlin.

$$\left.\begin{aligned} \omega &= 174^\circ\ 13'\cdot13 \\ \Omega &= 105^\circ\ 3'\cdot31 \\ i &= 140^\circ\ 36'\cdot58 \end{aligned}\right\}\ 1908\cdot0$$

log $q$ = 9·96412

*Ephemeris 12h. M.T. Berlin.*

| 1908 | α app. h. m. | δ app. ° ′ | log $r$ | log Δ | Brightness |
|---|---|---|---|---|---|
| Sept. 18 ... | 1 16·1 ... | +75 39·9 ... | 0·2651 ... | 0·1325 ... | 2·1 |
| ,, 20 ... | 0 40·7 ... | +76 17·2 | | | |
| ,, 22 ... | 0 0·4 ... | +76 31·9 ... | 0·2530 ... | 0·1039 ... | 2·5 |
| ,, 24 ... | 23 17·2 ... | +76 18·0 | | | |
| ,, 26 ... | 22 34·6 ... | +75 31·5 ... | 0·2405 ... | 0·0767 ... | 3·0 |
| ,, 28 ... | 21 55·5 ... | +74 12·1 | | | |
| ,, 30 ... | 21 21·8 ... | +72 22·2 ... | 0·2277 ... | 0·0520 ... | 3·6 |

The hazy, moonlit skies of the past week have militated against the observation of the comet in London, but, as will be seen from the ephemeris, the comet is becoming brighter, and will remain visible throughout the night during the present month, so that observations of it are very probable. The accompanying chart shows the

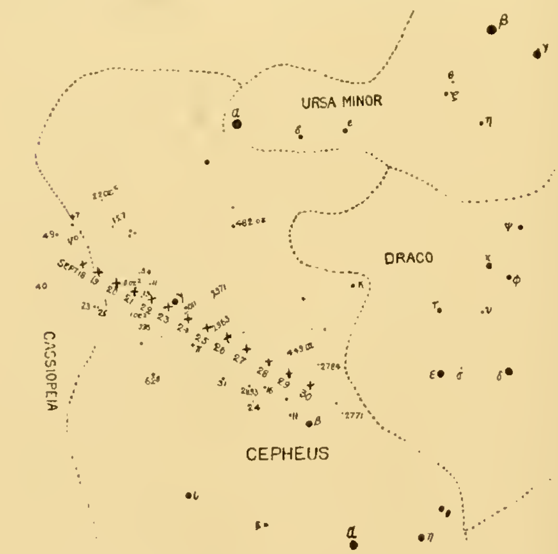



Chart showing apparent path of Comet 1908*c*, September 18–30.

apparent path of the comet, through the constellation Cepheus, for the remainder of September. It may be noted that at midnight on September 23 the comet will be about 4m. E. and 36′ S. of the 3·5 magnitude star $\gamma$ Cephei.

Observations made by M. Giacobini at Nice on September 3, 4, and 5, and published in No. 10 of the *Comptes rendus* (September 7, p. 474), showed that the comet then appeared as a round nebulosity, of some 15″ to 20″ diameter, having an ill-defined nucleus and a feeble condensation. A small tail, in position-angle 250°, was suspected. When the field was illuminated gradually, the comet disappeared with stars of the eleventh magnitude.

OBSERVATIONS OF JUPITER.—In No. 4272 of the *Astronomische Nachrichten* (p. 389, September 4) Prof. Barnard briefly discusses some of his observations of the Great Red Spot, and directs particular attention to the peculiar repellent action of this spot, acting on the material of the south equatorial belt to form the Red Spot Bay. In the earlier observations of 1879, and again in 1885 and 1886, the bay was strongly marked, the material north and following the spot on the southern edge of the equatorial belt being apparently repelled, and leaving a clear, symmetrical interval between the main body of the belt and the spot itself. Since then the spot has, to a great extent, lost its red colour, and has, apparently, become greatly enfeebled, yet this repellent action has apparently persisted as strongly as ever; at the present time the matter of the equatorial belt has advanced so far southwards as to enclose completely the spot, yet a clear, narrow space, symmetrical in figure with the spot, isolates the latter object entirely from the surrounding material of the belt.

In the same journal Father Chevalier, of the Zô-sè Observatory, places on record the results of his observations of an occultation by Jupiter of the star BD + 19°.2095 on May 21.

THE FRANKLIN-ADAMS PHOTOGRAPHIC CHART.—In a letter to the *Observatory* (p. 354, No. 400, September) Mr. Franklin-Adams states that, with propitious weather conditions, he hopes to finish his chart photographs of the northern hemisphere early in October. Those already completed have proved so successful that he fears that some of the plates for the southern hemisphere will have to be repeated in order to compare favourably with the northern plates. The counting and classification of the star images is to commence at once, experimentally and tentatively, and Mr. Franklin-Adams intends to lay his proposed method before an early meeting of the Royal Astronomical Society in order that he may receive the general advice of those experienced in such work.

ANOMALOUS FORMS OF THE CALCIUM LINE, K, IN PROMINENCES.—In No. 24, vol. ii., of the *Mitteilungen der Nikolai-Hauptsternwarte zu Pulkowo*, Prof. Belopolsky discusses the results obtained during 1906–7 in a photographic research on the anomalous forms of the "K" line of calcium in prominences photographed at the sun's limb.

The object of the observations was to study the motions of material at the sun's surface, and to provide data for the discussion of the question of anomalous dispersion. Prof. Belopolsky gives three plates of reproductions of some of the forms recorded, together with full details of the measurements and a brief discussion of the results.

THE HYPOTHETICAL PARALLAXES OF DOUBLE STARS.—From a study of fifty-four binary stars of which the proper motions are generally known, and for which he has calculated the hypothetical parallaxes, Dr. Doberck has obtained some interesting results, which he states briefly in No. 4271 of the *Astronomische Nachrichten*.

On the assumption that the annual parallax is, on the average, one-fifteenth of the proper motion, the masses of the two components should average thirty-six times that of the sun, but in the few cases where the parallax has been determined it is indicated that each single star is, on the average, only some 1·3 times the mass of the sun. It is also shown, in these results, that the hypothetical parallax amounts to about one-seventh of the proper motion where the latter is large, is equal where it is small, and is about 0″·03 where the proper motion is too small to be determined.

From the figures given it appears that the hypothetical parallax is not a function of the magnitude; even in the case of stars of the sixth magnitude, at which rapidly revolving double stars are most common, the individual results differ greatly *inter se*, whereas hypothetical parallax and proper motion are very closely related.

## METEOROLOGY OF THE INDIAN OCEAN.[1]

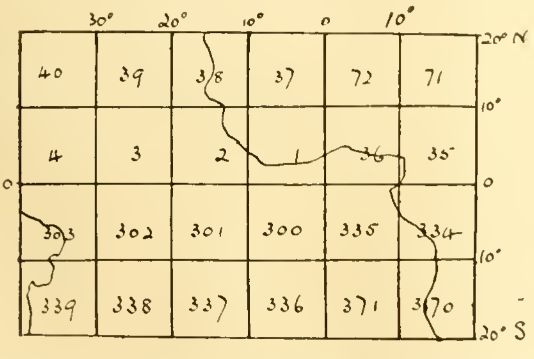
THE present volumes form a noteworthy contribution to the systematic knowledge of the meteorology of the sea on the lines laid down by the International Congress held in London in 1874. According to that plan the surface of the earth is divided by parallels of latitude and meridians, each 10° from the next, into sections numbered consecutively, starting from the square 0–10° N. and 0–10° W. of Greenwich, and proceeding west as indicated in the accompanying figure.

The observations from the meteorological log-books are then sorted according to the squares in which they are taken, and after a sufficient number has been obtained a definite scientific record of the meteorology of the region is made possible. If we look at it from another point of view, we might say that a knowledge of the "climate" of the different parts of the ocean may be obtained by this method.

The publications give the result of fifty years' observations, and some idea of the magnitude of the labour involved in reducing them to a form in which they are available for the sailor and the meteorologist may be gained from the fact that for each month about half a million observations had to be treated.

The tables give the values of the various elements for a large number of single degree squares in the following groups of 10° squares:—Nos. 63–69, 24–32, 323–332, 359–368, 396–406, 430–442, 466–478. These squares cover the whole of the Indian Ocean from Africa to Australia down to 50° S. lat.

The charts are not merely diagrammatic representations of the information contained in the tables. The guiding




principle in their construction has been to exhibit such information as a sailor will find useful, without overloading the map with unnecessary details or results of doubtful utility. On this account, also, the charts of cloud distribution, of rain and of fog, have been omitted from the present issue. The charts show the ocean current, the wind, the general circulation of sea and air, the mean pressure distribution, and the isotherms for the surface of the sea and for the atmosphere for each of the months September, October, and November. There are, in addition, three charts giving for each month the best routes for steam and sailing ships, at the same time showing the trajectories of cyclones and the northern limits of fog and floating ice.

An interesting result immediately seen on comparison of the wind and current charts is the fact that in regions where the wind is fairly steady in direction the ocean current flows to the left of the direction of the prevailing wind. Thus in the region of the trade winds, which blow from the south-east during these months, the ocean current flows steadily due west at an angle of 45° with the wind, while further south, where the prevailing wind is W. to W.N.W., the prevailing current comes from W. to W.S.W., although the regularity of the deviation is not so marked. This may be compared with Nansen's observations during the drifting of the *Fram* in northern latitudes. He found the direction of drift deviated 20°–40° to the right of the wind direction. The theory has been developed by Ekman (*Arkiv för Matematik*, vol. ii., No. 11), who found that in the open ocean, while the depth of the wind-produced current varied with the latitude, the deviation, an effect of the earth's rotation, was independent of the latitude and equal to 45°, except in the immediate neighbourhood of the equator. The current caused by the trade winds, on reaching the African coast, is deflected towards the south, and produces a marked effect on the temperature of the sea off the coast of Natal, where it is fully 5° C. warmer than in the same latitude in the open ocean or on the Australian coast.

A point especially worthy of commendation is the insertion in the tables of the number of observations on which each result is based. In the charts, too, the number of observations utilised for each 5° square is given. It is thus easy to see at a glance if an apparently anomalous result is doubtful owing to insufficiency of observations or really represents a feature worthy of investigation. In the pressure charts not only are the mean isobars drawn, but the mean pressure for each 2° square is inserted, one of the principal reasons for this being that small departures from the normal value in the barometric height are frequently in tropical regions a valuable indication of approaching cyclonic disturbances.

An important feature in the tables is the representation of the stability of the ocean currents and the wind. The value of this is taken to be the ratio of the resultant velocity to the mean velocity taken without regard to direction. It furnishes the sailor with an estimate of the probability of his meeting with the current or wind indicated by the resultant. It is an attempt at scientific statistical forecasting which will probably be further developed.

The number of observations of rain is given as a percentage of the total number of observations for each square, but no information is given regarding the amount of rain. No observations of humidity are published, an omission to be regretted in view of the importance of water-vapour both climatologically and in the thermodynamics of the atmosphere.

E. G.

[1] Koninklijk Nederlandsch Meteorologisch Instituut, No. 104. Oceanographische en Meteorologische Waarnemingen in den Indischen Oceaan, September, October, November, 1856–1904. Tabellen en Kaarten. (Utrecht: Kemink & Zoon, 1908.) Prijs (met atlas) 5.50 fl.

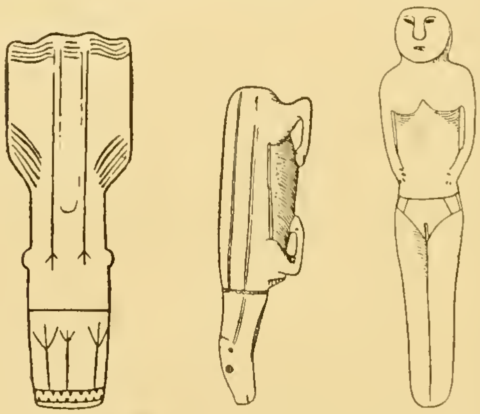
## THE EVOLUTION OF DECORATIVE DESIGN.

THREE explanations of the development of decorative design occupy the field at present:—first, that originally suggested by Prof. F. W. Putnam in connection with the ornamentation found on the pottery of the Chiriqui Indians, and independently advocated in this country by Mr. H. Balfour and Dr. A. C. Haddon, that conventional designs are developed from attempts at realistic representations, which gradually degenerate into a purely conventional representation, in which, at its later stages, the realistic origin can hardly be recognised; secondly, that of Semper, which emphasises the influence of material upon the development of the design; thirdly, the theory that the explanations of conventional motives are essentially secondary in character, and are due to the later association of the existing decorative forms with realistic designs. This last, the view propounded by Mr. A. L. Kroeber, Clark Wissler, and Dr. Franz Boaz, has now been re-stated and supplemented by fresh arguments and material by the last of these writers in a paper on the "Decorative Designs of Alaskan Needle-cases," published in vol. xxxiv. of the Proceedings of the United States National Museum.

This group of objects in their most generalised type displays the following features:—a tube slightly bulging in the middle; flanges at the upper end; small knobs under the flanges; a long concave face at the upper end of the tube; long parallel lines with small forks at their lower ends setting off the concave face; border designs consisting of lines at the upper and lower ends of the flanges and on the concave face; and an alternate-spur band at the lower end of the tube. The case itself is formed out of a strip of skin pulled into a tube, which protects the needle against breakage; and its most peculiar feature is a pair of wings or flanges at the upper end, below which are two small knobs on opposite sides of the tube.

This form of ornamentation is believed to be peculiar to Eskimo work, and does not occur in those parts of America or Asia which are beyond the sphere of Eskimo influence. The controversy, as now stated, turns mainly upon the diminutive knobs found in the Eskimo needle-case group, which appear to serve no practical end, and are, it is believed, purely conventional. This type of conventional ornament, according to the view of Dr. Boaz, is found to develop gradually into an animal design, such as that of a crouching beast, the knobs in the assumed later forms becoming heads, such as those of a seal, or even a partially or fully draped human figure, curiously reminiscent of the growth of the aniconic Greek pillar into an anthropomorphic image.

Dr. Boaz argues that it is impossible to believe that in this group the animal form was primitive; in other words, he attempts to prove that the seal-headed and similar more advanced designs could not have been developed by a degradation of a type which was originally more highly specialised. The process, it is contended, was the reverse of this, and the crude knob preceded the animalistic and later developments. "If we were to apply," he urges, "to the present series the theory of the origin of the conventional form from realistic motives, it would be exceedingly difficult to account for the general uniformity of fundamental type. It seems to me that on the basis of this theory we could not account for the diversity of realistic forms and the uniformity of the general type.



Characteristic forms of needle-cases, to show the evolution of type.

Neither does it seem possible to account for the series of types by the assumption of any influence of technic; and my impression is that the only satisfactory explanation lies in the assumption that the multifarious forms are due to the play of imagination with a fixed old conventional form, the origin of which remains entirely obscure. This I freely acknowledge. If, however, we are to form an acceptable theory of the origin of decorative designs, it seems a safer method to form our judgment based on examples the history of which can be traced with a fair degree of certainty, rather than on speculations in regard to the origin of remote forms for the development of which no data are available." Hence he explains decorative forms as "the results of the play of imagination under the restricting influence of a fixed conventional style." This influence of imagination is illustrated in the case of necklaces and leggings made by the American Indians, in which the tendency to use rhythmic repetitions of varying forms is specially apparent. Dr. Boaz sums up the discussion by remarking that "the development of decorative designs cannot be simply interpreted by the assumption of a general tendency towards conventionalism, or by the theory of an evolution of technical motives into realistic motives by a process of reading in; but that a considerable number of other psychic processes must be taken into consideration if we desire to obtain a clear insight into the history of art."

It is impossible to discuss in detail the views of Dr. Boaz in this important contribution. The weak points in the argument seem to be:—first, that the ultimate origin of the flanges and knobs in this group of objects remains unexplained; secondly, that it seems rash to assume that the historical development of the Eskimo form of design can be definitely established; thirdly, it may be urged that the objects themselves are of too special a type and found in a too limited area to supply a safe basis for such a wide induction as that which is here applied to the evolution of primitive art in general. It seems clearly necessary that a fuller comparison of this group with the types produced by other neighbouring tribes should be a preliminary to any further discussion of their origin and meaning.

It seems not impossible that this Eskimo form of decoration may be due to special influences of environment, technique, and general culture with which we are as yet imperfectly acquainted. This paper, however, with its abundant illustrations and ingenious interpretations of the evolution of decorative forms, must be taken into account by all future writers on the subject. In any case, it illustrates the danger, in the present imperfect state of our knowledge on this and other subjects connected with the thought and culture of so-called "primitive" man, of the dogmatic assumption that any one theory will account for the workings of the artistic faculty when exposed to the varying influences of imagination, culture, and environment.

## THE BRITISH ASSOCIATION.

### SECTION D.

#### ZOOLOGY.

OPENING ADDRESS BY SIDNEY F. HARMER, SC.D., F.R.S., PRESIDENT OF THE SECTION.

THE British Association meets this year for the fourth time in Dublin. The last occasion was just thirty years ago, when Sir William Flower presided over Section D, while Prof. Huxley was Chairman of the Department of Anthropology, at that time not raised to the dignity of a separate Section, and Sir Wyville Thomson was President of Section E. The last Dublin meeting was fortunate in having among its officers men who have left an enduring mark on Zoological science.

I can hardly come to the more immediate subject of my Address without referring to the death, on March 9 last, of Henry Clifton Sorby, who had been a member of the Association for nearly fifty years. Dr. Sorby was President of Section C in 1880; but although he does not appear to have presided over Section D, many of his sympathies were with Zoology. He belonged to a type which is becoming almost extinct with the increasing specialisation of science, having done pioneer work in more than one branch. His interest in Chemistry was no doubt responsible for his having taken up the subject of the pigmentation of animals, by his researches on which he is probably best known to Zoologists. During recent years he had devoted particular attention to the study of the marine fauna of East Anglia.

According to the popular estimate, Zoology is regarded as the branch of science that has perhaps the least reference to the details of practical life. The importance of the applications of Chemistry, Physics, Geology, Botany, and Physiology to questions which involve the welfare of the human race is obvious and universally admitted. But pure Zoology is often supposed to be a study of merely academic interest, and its relation to the practical concerns of mankind is not always apparent. It is no doubt true that many of the investigations undertaken by Zoologists are of a highly special nature; and yet when the sum total of the results achieved by workers in this science is estimated it will be found that the contributions of Zoology to the common stock of human knowledge are by no means of restricted application.

There is no conception which has more profoundly influenced thought in all branches of knowledge than the idea of organic evolution, in the development of which Zoology has shared the honours with its sister-subject, Botany. The present summer has seen a memorable event in the celebration by the Linnean Society, on July 1, of the fiftieth anniversary of the communication to that society of Papers, by Darwin and Wallace, which revolutionised the whole of Biology. There can surely have been few occasions when the commemoration of the jubilee of an epoch-making discovery has been attended by the man whose work was thus recognised. I am sure that I am expressing a unanimous feeling in saying that the award of the first Darwin-Wallace medal on that occasion to Mr. Wallace in person was a source of deep gratification to all men of science, and that the presence at the same meeting of others whom all Biologists must regard with peculiar respect gave the occasion a perfectly unique character.

The present century has seen a remarkable development of the study of the problems of heredity and variation, largely as the result of the interest awakened in the resuscitation of Mendel's experimental work from the oblivion in which it had remained for so many years, though the general problem is being attacked concurrently by investigators who attach more importance to the statistical method of study. Prof. Bateson, who has given the name "Genetics" to the experimental study of heredity, chose the advances made in that branch of Biology up to 1904 as the subject of his able address to Section D in that year. Some of the more recent conclusions of the workers in Genetics are to be discussed by this Section during the present meeting. It cannot be doubted that an accurate knowledge of the principles of heredity is destined to exert a marked influence on the practical concerns of humanity.

The study of diseases which are due to parasitic Protozoa has made striking progress during the last few years. Protozoology has become a distinct branch of Zoology, represented by its own journals and its own professors and lecturers, while it can command the resources of the schools of tropical medicine where researches are being carried on from which great benefits to humanity may be anticipated. Malaria, sleeping sickness, yellow fever, and the numerous diseases of domestic animals due to parasitic Protozoa such as Trypanosoma, Spirochæta, and Piroplasma, are some of the complaints which are now recognised as the objects of Zoological study. Most of these diseases are transmitted by blood-sucking Insects and Arachnids, an accurate knowledge of which has become a matter of pressing practical importance.

The history of Protozoology affords a complete vindication of the importance, even from a utilitarian standpoint, of conducting scientific investigations for their own sake, even though the likelihood that they will ever have any practical bearing may not at first be apparent. Some years ago it would have been generally supposed that the study of Ticks was a case of this kind, and that it could at most be of interest to the special students of the Arachnida. How far such a view would have been from the truth is well known, but we are suffering now from the comparative neglect of this group of animals in the past. There is still no satisfactory monograph by the aid of which the species of Ticks can be discriminated, and there are few Zoologists who would be prepared to express an opinion with regard to the determination of even those species that are the commonest and the most injurious. While it is clear that the investigation of the Arthropod carriers of parasitic Protozoa is essentially a Zoological question, it is equally true that the elucidation of the parasites themselves is largely dependent on the results that have been achieved by Zoological investigators who have worked without any thought of a practical outcome. The late Prof. Schaudinn, to whom we owe so many brilliant results in the study of the Protozoa, commenced his investigations from the Zoological side, and continued them in their applications to preventive medicine. It is generally admitted that the study of many of the tropical diseases can only be carried on by means of a due coordination between Zoological and Medical methods of inquiry.

As a further instance of the manner in which Biological science may react on other studies, I may mention the interesting theory which has recently been developed by Mr. W. H. S. Jones,[1] to the effect that the decay of the ancient civilisations of Greece and Rome was largely due to the introduction of malaria into those countries.

[1] "Malaria: A Neglected Factor in the History of Greece and Rome." (Cambridge: Bowes and Bowes, 1907.)

I can do no more than allude to Economic Entomology, a subject which has at present received but little official support in our own country, although its importance is fully recognised abroad, particularly in the United States of America, where large organisations are devoted to the combat with the Insect enemies of agriculture. We are fortunately spared some of the worst of the foes of vegetation which devastate other lands. But many of our cultivated plants suffer severely from the ravages of Insects and Arachnids; and it is perhaps not too much to hope that more systematic measures will some day be taken in this country to disseminate the knowledge by which this injury to agriculture may be minimised.

As a last illustration of the way in which Zoology comes into relation with practical matters, I may allude to the question of fishery investigation. Although much remains to be done in this connection, the importance of purely scientific work has been to some extent officially recognised. The Board of Agriculture and Fisheries in England, the Scottish Fishery Board, the Fisheries Branch of the Department of Agriculture and Technical Instruction for Ireland, and other organisations which are mainly or entirely supported by private funds, are in part devoted to the interests of the fishing industry. The Government has latterly participated in an international investigation of the North Sea, as the result of which many interesting facts have been recorded with regard to the life-histories of food-fishes, their migrations at various periods of life, the age at which they become sexually mature, and the nature of their food. These are questions that demand study by experienced Zoologists; and the interrelations of food-fishes and the organisms on which they subsist or with which they come into competition are so complex that a full study of the entire marine fauna appears to be a necessary preliminary to the elucidation of the questions of immediate practical utility.

I have tried to indicate that Zoology is a subject that has important relations with the practical concerns of mankind. But in Zoology, as in other branches of science, the principal advances have been made by investigators who have studied it for its own sake, without thought of the practical outcome. It would undoubtedly be a misfortune should an entirely utilitarian spirit become dominant in the pursuit of science. In the full conviction of the truth of this statement I venture to invite your attention to certain questions connected with the Polyzoa —a somewhat neglected group of animals which I do not profess to be able to connect in any direct way with practical matters. In choosing this subject I have been influenced by the belief that it is well for the President of a Section to speak on matters of which he has had practical experience.

During the course of my studies on the Polyzoa I have been conscious of the existence of many unsolved problems and difficulties, some of which are connected with the functions, distribution, and variations of certain remarkable appendages known as "avicularia" and "vibracula." Although the facts bearing on the significance of these organs are familiar to specialists only, they appear to me capable of throwing light on questions of general Biological interest, particularly in connection with variation in animals that increase by budding.

The statement has often been made, as the result of a theoretical conception of the physical basis of heredity, that the asexual method of reproduction gives rise to little or no variability. Although there are many reasons for doubting the validity of this conclusion, it may be well to state at the outset that the Polyzoa, which are without exception characterised by increasing in an asexual manner, show a high degree of variability in the individuals thus produced. So much is this the case that the want of fixity of type which results from the tendency to vary renders the definition of species particularly difficult in this group of animals.

Meeting as we do at Dublin, there is a special appropriateness in discussing the Polyzoa, as a tribute to the memory of a distinguished Irish naturalist, J. V. Thompson, to whom we owe not only the name Polyzoa, but also the first clear conception of what these animals really are.

In the fifth memoir, published at Cork in 1830, of a short but brilliant series of Papers,[1] Thompson was the first to demonstrate the essential nature of the differences between the Polyzoa and the other "Zoophytes" with which they had previously been classified. G. J. Allman, who at a later period did so much to throw light on the structure and natural history of these animals, particularly by his classical monograph on the Fresh-water Polyzoa,[2] was also an Irishman, who was born at Cork, and for some years held the professorship of Botany in the University of Dublin. Thomas Hincks, another worker who was pre-eminent for his knowledge of the Polyzoa and for the importance of his researches in this field, held professional appointments both at Cork and at Dublin for several years.

The Polyzoa are a group which is quite unknown to most persons who are not Zoologists. Before coming to my special subject, the variations of the avicularia, I may for this reason, perhaps, be excused for attempting to explain what the Polyzoa are like, and, in particular, what are the nature and functions of the structures we have to discuss.

The Polyzoa are a Class of aquatic organisms of world-wide distribution, and including a large number of species. They occur both in fresh water and in the sea, and the marine forms are found from between tide-marks to the deepest abysses of the ocean. Some of the species are among the commonest objects of the sea-shore, and others may be obtained in numbers by the use of the dredge or trawl. They often occur as delicate encrustations, usually calcareous, on plants, stones, or shells; or they may assume the appearance of sea-weeds, corals, or Hydroids. Although most of them are of comparatively small size, they are usually large enough to be recognised by the naked eye, while the largest of them reach a diameter of a foot or two.

The Polyzoa are always colonial animals, the colony consisting of a number of individuals which are in organic connection with one another, though they may appear at first sight as a series of isolated units. Each of these units consists of a body-wall, which is usually calcified and is termed the "zoœcium," since it was at one time supposed to constitute a sort of house for a zooid known as the "polypide." The idea of a dimorphism of individuals expressed by this nomenclature is no longer accepted, but the terms themselves are still conveniently employed for descriptive purposes. The polypide consists in reality of the visceral mass of the zoœcium, together with the series of ciliated tentacles which are used for the capture of food. The tentacles are protrusible, but are commonly found retracted into the interior of the zoœcium, in which condition they lie in a thin-walled introvert or "tentacle-sheath," which opens to the exterior by an "orifice" in the wall of the zoœcium. In the suborder Cheilostomata, to which my remarks will principally refer, the orifice is closed, during the retracted condition of the polypide, by a chitinous lid or "operculum."

In the great majority of cases the colony is inaugurated by the fixation of a free-swimming larva, which has been produced from an egg by the ordinary sexual method. On the completion of its metamorphosis the larva becomes the first zoœcium of the colony, and is then known as the "ancestrula," a term introduced by Jullien to signify that it is the ancestor of the future colony. In a large number of species belonging to the most diverse genera of Cheilostomes the ancestrula has a certain definite character which appears to have no relation to that of the individuals to which it gives rise by budding. The type of ancestrula in question has a striking resemblance to a single zoœcium of many of the species of the existing genus Membranipora, and is characterised by having a series of marginal spines which surround a region closed by a chitinous membrane, at one end of which is situated the operculum. That this form of ancestrula has a definite significance is indicated by its wide occurrence among Cheilostomes and by the fact that the same cannot be said of any other form of ancestrula, and is confirmed by the palæontological occurrence of Membranipora as one of the earliest genera of Cheilostomata.

[1] "Zoological Researches and Illustrations."
[2] Ray Society, 1856.

The ancestrula gives rise by budding to daughter-zoœcia, which usually assume from the first the characters proper to their species. In the growing colony the formation of new zoœcia takes place at the expense of a marginal zone, which contains the tissues concerned in the bud-development. Omitting the consideration of special regenerative processes which may take place, a zoœcium which has once been constituted at the growing margin of the colony does not, as a rule, possess the power of giving rise to new zoœcia, although it commonly has the faculty of producing sexual cells from which free larvæ may develop.

In the majority of the species of Cheilostomata many of the individuals of the colony have the form of the so-called avicularia. An avicularium is characterised by possessing a chitinous "mandible," which can be closed with great force by strong occlusor muscles, the organ being thus essentially of a prehensile nature. There can be little doubt that the mandible is a modification of the chitinous operculum which closes the orifice of the tentacle-sheath in Cheilostomata. It thus follows that avicularia are restricted to this particular division[1] of the Polyzoa. In the avicularium the operculum has become relatively and often absolutely enlarged, and its muscles have become more powerful than those of the unmodified zoœcia. The internal viscera have, as a rule, disappeared, and there are thus neither tentacles nor alimentary canal. The body-wall, or zoœcium, has become a case which contains the muscles, while part of it has been prolonged into a beak-like structure or "rostrum," which, with the chitinous mandible, constitutes the prehensile mechanism.

In Bugula and its allies the avicularium has the form to which its name refers, and has a striking resemblance to the head of a bird like an eagle or vulture. This resemblance is due, not only to the general form of the structure, but also to the hooked and beak-like shape of its rostrum and to the narrow neck by which it is connected with the zoœcium on which it is borne. The avicularia of Bugula have considerable powers of movement, and in the living condition they may be seen to bend backwards and forwards on their flexible neck, their range of action being thus considerably enlarged. The mandible is ordinarily held wide open, but it closes with great force when some foreign object is placed between the jaws. An avicularium which has in this way seized a small worm, for instance, is known to be able to retain its capture for many hours, in some cases for more than an entire day.

In the majority of Cheilostomata the avicularia are, however, not stalked. They occur scattered over the colony in a considerable variety of positions, and usually appear as appendages rigidly connected with the walls of the zoœcia.

More than one attempt has been made to explain the functions of the avicularia. The distribution of these organs indicates, I think, that the simplest and most obvious explanation is the correct one—namely, that, like the pedicellariæ of Echinoderms, they are defensive organs. The ordinary unmodified opercula probably have the same function in many cases; and if account be taken of the fact that the avicularium is morphologically a modified zoœcium it becomes easy to understand that the defensive office of the opercula has been made more efficient in specially modified zoœcia which concentrate their energies on this one function alone.

A casual inspection of a number of Cheilostomes taken almost at random reveals the fact that the avicularia are specially common in the immediate neighbourhood of the orifice of the tentacle-sheath and of that of the "compensation-sac."

This is a thin-walled cavity which in a considerable proportion of the Cheilostomes opens to the exterior at the proximal border of the operculum. Its principal function is to permit protrusion and retraction of the polypide to take place, since in a zoœcium with completely rigid walls the act of protrusion could not occur if the temporary removal of structures of considerable size were not compensated for by the admission of water into the space included by the rigid body-wall. At each movement of

[1] It may be noted that Palæontologists have described structures which they have regarded as avicularia in Polyzoa which do not belong to the Cheilostomata.

protrusion, therefore, a volume of water corresponding with that of the protruded organs is admitted into the compensation-sac, the dilatation of which, by means of radiating muscle-fibres, is the cause of the protrusion, and is again evacuated when the polypide is retracted. These alternate actions of filling and emptying the compensation-sac with water from the outside are probably of importance in the respiration of the animal. The advantages of having avicularia in such a position that they can guard the orifice from which the tentacles are protruded and that of the compensation-sac are too obvious to require detailed discussion.

The avicularia probably afford little if any protection against the attacks of the larger foes, such as Fishes, Echinids, and Nudibranch Molluscs, which are said to browse on Polyzoa. But there is one group of enemies against which the opercula and the mandibles are probably particularly effective. These are encrusting organisms, including other species of Polyzoa; and indeed the enemies against which a Polyzoon has to provide are probably in a special degree the members of its own class.

In many Polyzoa which afford large surfaces suitable for the growth of encrusting organisms the older parts of the colony, where the opercula and mandibles are no longer in working order, do actually harbour large numbers of encrusting Polyzoa, Sponges, Ascidians, and other organisms. These are usually absent in the active parts of the colony nearer the growing margins. In these positions the only animals which obtain a footing are such forms as the Infusorian Folliculina, adapted by its minuteness to find a place between the defensive appendages, or such organisms as are attached by means of delicate creeping stolons or rootlets that can find their way between the opercula and mandibles without being damaged by them. A branching species fixed by a narrow base may do little harm to a Polyzoon on which it is growing. But the effects of an encrusting species would be different, since the orifices of the colony which is being overgrown would be occluded, and the polypides entirely cut off from the outer world. Although experimental evidence is at present wanting to prove this view, I have little doubt that the avicularia are specially important in preventing the fixation of the larvæ of encrusting species. The larva is of course very vulnerable, and it cannot become the founder of an adult colony unless it can find a secluded spot in which it is safe from undue disturbance during the critical time of its metamorphosis. The avicularia are well adapted by their form for warding off larvæ. Those that have the so-called "duck-billed" or "spatulate" form are in many cases large enough to catch or crush a larva without difficulty, while those which have a mandible terminated by a spike-like projection must be even more destructive to the life of any minute organism which is so imprudent as to stray within their reach. In some of the avicularia belonging to this latter type the mandible is strongly compressed along the greater part of its length, and may then assume the shape of a knife-blade, with a sharp cutting edge and a thicker back. The blade shuts down into the calcareous rostrum of the avicularium in such a way that its action may be compared to that of a pair of scissors. It cannot be doubted that this form of avicularium has a high protective value.

In some cases the mandibles or the opercula are toothed. The teeth are specially strong in certain species of the genus Steganoporella, where the opercula become most formidable weapons. The large development of the occlusor muscles proves that the closure of these opercula must take place with much force.

The protective value of the avicularia may be illustrated by the distribution of these organs in Retepora, the species of which usually grow in the form of a calcareous network, with oval meshes or "fenestræ" between the branches. These are furnished with an elaborate armature of avicularia, which usually occur in large numbers and in considerable variety of form and size. Some of them are scattered over the front surface, on which alone the zoœcia open, while others occur on the more unprotected backs of the branches, where there are no zoœcial orifices. To guard against an attack from the rear the margins of the fenestræ are frequently furnished with avicularia, among which some are usually of a specially large size, and are well situated to intercept any larva or adult animal that might attempt to pass through a fenestra.

A healthy Retepore is usually completely free from encrusting organisms in regions where the avicularia are functional. One of the few exceptions I have noticed to this rule is specially instructive. In this case a small encrusting Cheilostome colony is growing near the edge of the Retepora frond. The primary individual or ancestrula of the encrusting colony is readily distinguishable, and its position shows that the larva from which it was formed must have attached itself to the growing margin of the Retepore, a region in which the avicularia were not fully formed. Having thus established itself, the colony has succeeded in invading a small region of the adjacent parts where the zoœcia are still vigorous and healthy. A dead Retepora, on the contrary, forms a substratum which is well adapted for the growth of various organisms, such as other Polyzoa, Sponges, Hydroids, Compound Ascidians, and Foraminifera.

Although the avicularia are thus effective in preventing the overgrowth of the colony by most of the organisms that might otherwise settle there, there are one or two animals of suitable habit which have succeeded in establishing themselves in the very midst of the defensive works. In species of Retepora from the Malay Archipelago [1] I find that a considerable proportion of the colonies are infested by a Gymnoblastic Hydroid of Syncoryne-like appearance. The association of this with its host is so intimate that the hydrorhiza becomes completely included in tunnels formed in the calcareous mass of the Polyzoon, where it is, of course, safe from the avicularia. These tunnels, the walls of which are secreted by the Polyzoon, open to the exterior by tubular apertures situated on the margins of the fenestræ and on other parts; and they are so definite in their appearance, and often so regularly arranged, that it might be difficult to believe that they were not a normal feature of the Retepora were it not possible to demonstrate their relation to the Hydroid.[2]

There is one other organism which has a definite relation to colonies of Retepora in Malay waters. This is Loxosoma, a stalked Polyzoon which leads a practically solitary life owing to the fact that its buds break off as soon as they have reached maturity. The Loxosoma no doubt succeeds in enjoying a secure existence, even though it is surrounded by avicularia, owing partly to its stalked form and partly to its minute size. It is commonly found in considerable numbers, and often attaches itself in such a way that it projects into one of the fenestræ, where it is as far as possible removed from the dangerous neighbourhood of the avicularia.

We have thus seen that, while the species of Retepora are adequately protected against many encrusting or epizoic organisms, there are one or two animals that have succeeded in evading the attacks of the avicularia, which, it must be remembered, are rigidly attached to the colony, and cannot go in search of any enemy that keeps out of their way. The efficient avicularian protection may well be responsible for the fact that Retepora is a common and widely distributed genus, flourishing in both shallow and deep water. Not only is it found in large numbers in the most diverse localities, but it has differentiated itself into a large number of species, among which avicularia occur in great profusion and in a great variety of forms. But so soon as the avicularia cease to be active we find that numerous organisms settle on the unprotected branches; and a dead colony of Retepora is accordingly usually found to be invaded by numbers of other animals.

One other familiar case may be mentioned illustrative of the means by which a Polyzoon may be protected from

[1] The greater number of the facts referred to in this Address have been observed during my study of the Polyzoa collected during the *Siboga* expedition.

[2] It may be noted, as has already been done by Alcock ("Ann. Mag. Nat. Hist.," ser 6, x., 1892, p. 207), that many other cases are known in which there is an association between a Gymnoblastic Hydroid and some other animal. The interesting case of the association of a Gymnoblastic Hydroid (Stylactis) with a fish (Minous) described by Alcock has also been described, more recently, by Franz and Stechow (*Zool. Anzeiger*, xxxii., 1908, p. 752). Another case of the association of a Cœlenterate with a Polyzoon has been recorded by Haswell and by Kirkpatrick, who have called attention to the occurrence of a small "Actinid" which forms definite cavities in a massive calcareous Cheilostome from Australian waters. There is in this case no satisfactory evidence to show what the Cœlenterate really is.

encrusting organisms, and at the same time of the success with which certain animals have ignored the defensive works that are effective against ordinary foes. This is the common *Flustra foliacea* of our own shores, in which, although avicularia are present, the defence is provided largely by the numerous stiff spines which make its surface irregular, and thus unsuitable for the growth of an encrusting organism. But certain delicate Polyzoa, such as Crisia and Scrupocellaria, which are attached by fine rootlets, flourish on this species, their rooting processes being able to adapt themselves to the irregularities of the surface, and to escape the closure of the opercula and mandibles. A Gymnoblastic Hydroid (*Hydranthea margarica*) of a similar mode of growth is also known to occur on healthy colonies of *Flustra foliacea*.

In a large number of erect Polyzoa the colony, or zoarium, assumes the form of a small branching tree-like growth in which, as in Retepora, the zoœcia open on one surface only of the branches. The opposite surface is often devoid of any armature of avicularia or vibracula, a fact which at first sight seems opposed to the view that these structures are protective. But I think that in some of these cases the form of the zoarium affords an answer to this objection, since the branches are so crowded that the avicularia of the front surface of one branch are probably quite capable of affording protection to the backs of the nearest branches. It may be noted that Scrupocellaria and Caberea, in which vibracula occur on the backs of the branches, usually have a much laxer mode of growth than Bugula, in which the back is unprotected.

In some other erect species there are no avicularia at all. But here we often find, as in Euthyris, that the whole of the frond is covered by an organic membrane, the "epitheca," which invests the calcareous parts; and it seems to me probable that this epithecal layer is itself protective. Schiemenz has shown that it is an advantage to certain Molluscs to have an internal shell, since Starfishes can devour Molluscs to the shells of which they can attach their tube-feet, while they can obtain no hold on the slimy surface of a Mollusc which has covered its shell by part of its soft tissues. Although the enemies to be guarded against are not the same in the Polyzoa, there may, none the less, be an advantage in having the calcareous parts covered with an organic membrane. The species which are especially liable to the attacks of Folliculina appear to be those in which the calcareous parts are but little protected, as in Cyclostomes such as Lichenopora; while this Infusorian readily establishes itself on dead parts of Cheilostomes which have lost the epitheca that covers their active regions. The encrusting species of Polyzoa doubtless prefer a hard, calcareous surface on which to grow to a soft, yielding membranous surface.

As a further factor with which the absence of avicularia may be correlated may be mentioned the shape of the individual zoœcia. There are many cases, such as *Schizoporella Cecilii*, *Mucronella ventricosa*, and a number of others, in which the zoœcia of a species devoid of avicularia are very convex in their external shape. The conjunction of a succession of convex zoœcia is probably important in preventing the encroachments of encrusting species, which more easily adapt themselves to a level surface than to one which is strikingly uneven or irregular. This is analogous to the case of *Flustra foliacea*, which we have already noticed, where the protection appears to depend largely on the development of spines. The irregular surface of many Cyclostomes, which is due to the projection of the free ends of the zoœcia, is probably similarly effective in preventing overgrowth by foreign organisms.

In the vibraculum the part that corresponds with the mandible of the avicularium has been prolonged into a thread-like structure, the "seta," which is moved by muscles corresponding with those of the avicularium.

The setæ of Caberea are very large, and they close into oblique grooves which run along the back of the branch. The protective value of these setæ is well shown in a specimen I have observed from Torres Straits, in which a minute encrusting Cheilostome has formed a single row of zoœcia along the region between two of the vibracular grooves, but has not extended into any part where it would be subject to injury by the movements of the setæ.

The vibracula are, however, probably used for other purposes besides the protection against living foes. They no doubt serve to brush away foreign particles which might otherwise settle on the surface of the colony and block up the orifices. This function has been suggested for the vibracula of the so-called Selenariidæ, a group of forms which agree in having a zoarium of a discoidal or inverted saucer-like shape. The colony is believed to rest freely on the bottom, on the edge of its concave base, though I have some evidence that it may be attached to the ooze by means of very delicate, flexible, rooting processes. Some at least of these Selenariiform species occur in situations where the ground is covered by Globigerina ooze, the settlement of which on the convex surface bearing the orifices is probably prevented by the vibracula. It is now generally admitted that his type of colony has been independently acquired in several cases, the so-called family being, in fact, an entirely unnatural assemblage of genera. It may be worth while to point out in passing that I have noticed in several cases that the Selenariiform colony commences its existence on a Foraminiferan shell or other minute object, in the absence of larger surfaces on which fixation can be effected, and that the characteristic discoidal form is due to the growth of the circular edge of the colony beyond this initial supporting base.

But my object in introducing this group of Cheilostomes at the present point is to direct attention to the relatively enormous size which is reached by the setæ of the vibracula of some of the species, a size which is so great that it has even been supposed that these appendages are used as oar-like organs of locomotion. In a specimen of *Selenaria hexagonalis*, from South Australia, in the Museum of Zoology at Cambridge, the setæ have been colonised by a minute Cheilostome belonging to the genus Eucratea. It might be said that in this case the setæ have almost over-reached themselves, since they have become so large and powerful that another species is minute enough to find a home on the protective mechanism itself.

Having thus dealt with the probable functions of the avicularia and vibracula, we may now return to the consideration of the forms assumed by these appendages and of their distribution in the colony. The protective function which they appear to possess prepares us for finding, as is actually the case, that they are modified in an extraordinary number of directions. But although they occur, in one form or another, in the majority of Cheilostomes, they may be completely absent in an entire genus, in certain species of a genus, in certain varieties of a species, or in individual colonies of species which normally possess them. They are often wanting on some of the zoœcia, though present on most of the zoœcia, of a colony; and they may vary to a considerable extent in the position they assume on the zoœcium. Not only are they thus variable in their occurrence, but they show equally striking differences in their individual characters. They may be all of one kind in a single species, or two or more kinds may occur distinguished by size, by the shape of the rostrum and mandible, or in other ways. We thus come to the consideration of the question how far these appendages can be used in the discrimination of species.

The characters on which species are founded in a group of colonial animals like the Polyzoa obviously differ in certain respects from those which are used in distinguishing species in organisms that lead a solitary existence. In the colonial forms we are concerned partly with the mode of association of the individual units, partly with the manifestations of dimorphism or polymorphism shown by those units and partly by the features of the individuals themselves. Among the Cheilostomatous Polyzoa the dimorphism or even polymorphism of the individual, due to the presence in the colony of avicularia and vibracula, is of special importance.

While the characters of the avicularia have accordingly long been used by systematists for distinguishing species, no one—so far as I am aware—has hitherto suggested any hypothesis which helps us to form a reasonable conception of the significance of the innumerable modifications undergone by these organs; nor do I think that the problem has ever been fairly stated.

The difficulty of understanding the evolutionary significance of the avicularia arises in part from the fact that the occurrence and distribution of these structures appear in many cases to give but slight indications of affinities. It cannot, for instance, be assumed, without further evidence, that two species possessing an identical type of avicularium are nearly related. The complete absence of avicularia in a particular species is no sufficient reason for removing that species from an assemblage of forms in which avicularia are always present. And, lastly, there may be good grounds for believing that two forms with entirely different types of avicularia are closely related, and in some cases may even belong to the same species.

The result of a comparative study of the Cheilostomata leads, in fact, to the conclusion that although certain genera or species are characterised by the possession of one or more definite types of avicularium or vibraculum, other genera or species show no such constancy in this respect. The occurrence of the same type of avicularian appendage in the species of widely separated genera and the diversity of type of avicularium within the limits of a single genus or species render it most difficult to frame any theory that will account for the facts. Are we to assume that a given type of avicularium has been evolved independently in a number of cases, or must we suppose that species with that type have inherited it from a common ancestor? If the latter hypothesis be the correct one, we seem to be led to the conclusion that the ancestral Cheilostomes were provided with most of the types of avicularia that actually occur in existing species, many of which have lost one or more of those types.

In trying to arrive at some conclusion with regard to these points we may notice, in the first instance, one fact which stands out with great distinctness—namely, that, whatever the modifications of the avicularium may be, the mandible is usually either acutely pointed at its free end or rounded and spatulate at its termination. The difference may at first sight appear unimportant, but I am inclined to believe that it is an indication which may lead us to results of great significance.

Though it may be going too far to assert that all avicularia belong to one of these two types, there is usually no difficulty in recognising either the pointed or the rounded character in every avicularium present on a colony. The distinction may be observed by inspecting the form of the rostrum in a dry preparation of a part of the zoarium, but it is seen with more certainty when the mandibles have been isolated and are examined in Canada balsam. So striking is the difference that the inquiry naturally suggests itself whether there is any indication of the evolutionary meaning of the two kinds of avicularium. It appears to me probable that a condition which is characteristic of the existing genus Steganoporella may furnish the answer to this question. In this genus avicularia are typically absent, but in each species the zoœcia are of two kinds, distinguished by differences in the shape and structure of the opercula and orifices. The anatomy of the zoœcia is known in but few cases, but in those that have been observed both kinds of zoœcia possess polypides. In one division of Steganoporella the more differentiated zoœcia show some resemblances to the pointed type of avicularium, while in a second division they more nearly resemble rounded avicularia. I am inclined to believe that these conditions correspond respectively with the two kinds of differentiated avicularia of other Cheilostomes.

The avicularia most commonly met with occur as appendages of the ordinary zoœcia, which alone constitute the main framework of the colony. But in addition to these, the "adventitious" avicularia of Busk, we find, although less commonly, another kind known as the "vicarious" avicularium, from the fact that it occupies the place of an ordinary zoœcium, with which it agrees more or less closely in point of size. Its mandible is usually of the rounded type, appropriately referred to as "duckbill-like," and is readily seen to represent the operculum of an ordinary zoœcium. Compared with this the mandible and the orifice which it closes are greatly enlarged, while the occlusor muscles have become correspondingly increased in size. The polypide is generally absent in the vicarious avicularium.

Pointed avicularia of the vicarious type occur normally in the species of Onychocella, which, alike by their structure and by their early palæontological appearance, may be regarded as representing a primitive type of the Cheilostomata. Vicarious avicularia with a rounded mandible occur in certain species which I refer provisionally to Siphonoporella, as well as in a small proportion of the species of Membranipora and Flustra. All these may fairly be regarded as belonging to a comparatively undifferentiated type of Cheilostomata, and their vicarious avicularia are usually the only ones present. It is thus not improbable that the avicularium in these cases really represents an early stage of evolution. But we must notice that precisely similar rounded vicarious avicularia make their appearance occasionally in species of a much more differentiated type, as in the well-known *Schizoporella Cecilii*[1] and in certain other species which may for the present be referred to the same genus. In the majority of the very numerous species of Schizoporella vicarious avicularia are not known to occur, and it is thus impossible to regard them as a typical attribute of the genus.

The vicarious avicularia, which by their position and general structure are so easily comparable with the ordinary zoœcia, are usually supposed to represent an initial stage in the evolution of the avicularium. But if this view be correct, how are we to account for the sporadic way in which these structures occur in a series of genera such as Membranipora, Flustra, Schizoporella, and Cellepora, the last two of which, at any rate, are highly specialised in other respects? What conclusion can we draw from the association, in one and the same colony, of this type of avicularium with adventitious avicularia of the most specialised description? How can we explain the fact that each kind of avicularium occurs in certain species, but not in all the species, of many distinct and not specially related genera? And, lastly, what is the significance of the fact that certain species of a genus which is normally provided with avicularia may be totally destitute of these organs? These are some of the problems of which no satisfactory solution has at present been given. On the ordinary view of the way in which the species of a genus are interrelated we should perhaps not expect to find that two species which are closely similar in other respects may be distinguished by possessing entirely different types of avicularia.

I am aware of the fact that it is perhaps premature to indulge in speculations which are unsupported by experimental evidence. But it appears to me worth while to suggest that some of our difficulties might be removed by appealing to the results obtained by workers on Mendelian inheritance. An essential part of the theory here involved is that in the formation of the gametes of an organism there is a segregation of certain paired or "allelomorphic" characters whereby some of the gametes are endowed with qualities by virtue of which they transmit one of the characters, while the rest of the gametes become capable of transmitting the characters of the other member of the allelomorphic pair. It has recently been made probable by Prof. Bateson, whose views have been confirmed by others, that the actual appearance of a particular character may be dependent on a coupling of two allelomorphs belonging to distinct pairs. If only one of them is present the character will not show itself. The phenomenon of reversion on crossing is thus explained as due to the combination of allelomorphs present in the isolated condition in two parental forms.

Is it not possible that the perplexing occurrence of vicarious avicularia in some of, but not by any means in all, the colonies of certain species may be interpreted as a reversion due to the combination of two or more allelomorphs that may not have occurred together in the parental forms? We have seen that there is some reason to believe that these avicularia are really of an archaic character, from their occurrence in certain genera of a primitive type, known in some cases by palæontological evidence to have appeared early in the evolution of the Cheilostomata. We may further remember that we have distinct evidence that Cheilostomes of a differentiated type may retain certain primitive characters, in the occurrence of a Membranipora-like form of ancestrula in so many of them. If, then, we may suppose that the appearance of vicarious avicularia is due to a combination of more than one allelomorph we may recognise the possibility that the

[1] Kirkpatrick, "Ann. Mag. Nat. Hist." (6), v., 1890, p. 21.

ancestrulæ of a given species still carry the determinants representing those allelomorphs. In species in which the vicarious avicularia are of normal occurrence there is no difficulty in this hypothesis. In others, of which examples may be found in Schizoporella, the vicarious avicularia make their appearance rarely, in a very small proportion of colonies. In these cases the facts might be accounted for on the hypothesis of the chance recombination of allelomorphs which are ordinarily separated, unless, indeed, it should prove to be the case that the vicarious avicularia represent a recessive character which is usually prevented from making its appearance by some dominant factor.

A single series of cases of this kind will not carry conviction, but there are many facts with regard to the distribution of adventitious avicularia that may point in the same direction. We may recur to the fact that the form of these appendages may be eminently characteristic of a whole series of species which from their similarity in other respects are naturally associated in a single genus or family. The most striking instance of this is, perhaps, the genus Bugula, in which we find the avicularium *par excellence*. The variations of this type of avicularium are comparatively slight, and for the most part depend on differences in position with regard to the zoœcia and on minor modifications of size, shape, and length of stalk. Both in Bugula and in the allied genus Bicellaria the avicularian characters may be described as relatively constant; and since they belong to a type that is rarely met with in other genera, they seem to confirm the evidence afforded by other structural features that the species which possess them are related to one another. But even in Bugula, where the avicularia reach the summit of their development, we meet with species or varieties in which these appendages are invariably absent throughout the colony. This may be illustrated by *Bugula neritina*, a widely distributed species which in the Mediterranean and certain other districts is remarkable for the complete absence of avicularia, although in other structural features it shows a close affinity to other species of Bugula. In Australian and Oriental waters, however, there occur forms which can hardly be distinguished from *B. neritina* except by the fact that they always possess numerous avicularia of the specialised character that is so distinctive of the genus. It does not matter for our present purpose whether these are to be regarded as a variety of *B. neritina* or not. If the appearance of avicularia may be regarded, on Mendelian principles, as due to the presence of one or more allelomorphs, it is possible to understand that these may be omitted in certain cases, and that there may thus be a close affinity between two forms, one of which differs from the other in what appears at first sight so essential a respect as the complete absence of the avicularia, which we are justified in regarding as the most important feature of the genus.

A second case of the same general nature may also be noticed. In the family Cellulariidæ are included a number of delicate erect species which are commonly placed in the genera Caberea, Scrupocellaria, Menipea, and Cellularia. The first two of these are distinguished by possessing vibracula as well as avicularia. Menipea is defined as possessing avicularia, but no vibracula; while *Cellularia peachii* does not possess either kind of appendage. A species known as *Amastigia nuda* has been placed in a separate genus because of the absence of vibracula and their replacement by avicularia, while in other respects it agrees with Caberea, in which the vibracula reach a development not exceeded by those of any other Cheilostome. Before considering the bearing of these facts we may appropriately consider another instance taken from the same family, although by doing so we are for the moment leaving the question of the avicularia. In the genera Caberea, Scrupocellaria, and Menipea certain species are distinguished by having the free surface of the zoœcium protected by a peculiar spine known as the "scutum," which is usually flattened and much expanded at its free end, where it overarches the membranous frontal surface in such a way as to cover and presumably to protect it. But in each genus other species are characterised by the complete absence of the scutum, while in others it occurs in varying degrees of reduction.

We have thus several cases in which certain species differ from their near allies in the complete absence of a structure which is, as a rule, one of the most distinctive features of the genera to which they are respectively assigned. Should it be possible to prove that the appearance of the organ in question, whether avicularium, vibraculum, or scutum,[1] was of the nature of an allelomorphic character, its disappearance would be readily intelligible.

The facts which I have indicated with regard to the so-called Cellulariidæ have not hitherto been sufficiently discussed; but I imagine that most systematists who have considered the question have assumed that the scutum, for instance, has undergone parallel evolution in Caberea, Scrupocellaria, and Menipea, either having been independently evolved in each of the three cases (a most improbable supposition), or having independently undergone a series of regressive changes of precisely similar character in the three genera.

But it is perhaps in the mode of occurrence of adventitious avicularia that we find the strongest reason for believing in the existence of some form of alternative inheritance. We may indeed go so far as to assert that alternative development does actually take place, whether the explanation of the facts is given by the Mendelian theory or not. The difference between the pointed and the round avicularia is a very definite one, which—it is no exaggeration to say—may be observed in hundreds of species. When these species are arranged under genera according to the result of a study of the whole of the evidence derived from all the characters that have proved valuable in classification, we find that many genera include some species with one type of avicularium and others with the other type. It should perhaps be pointed out that the validity of many of these genera is a matter on which differences of opinion exist. The subject is undoubtedly a difficult one, and we are far from having arrived at any certainty with regard to the classification of the Cheilostomata. But it is perfectly certain that we could not utilise the two kinds of avicularia in dividing these Polyzoa into two main series, since there are innumerable cases in which both kinds occur in a single colony. This is a fact to which I shall return later.

We may accordingly maintain that, although much is probably faulty in our present system, we have clear evidence that the same genus may include species which differ in the type of avicularium; and, moreover, that these are not exceptional, but, on the contrary, are of common occurrence. A few instances will make these points clear.

In the encrusting species and in certain others the avicularia commonly occur, as we have already seen, in a position near the orifice of the zoœcium, where they are usually either lateral or suboral. In one of the species with lateral avicularia these appendages may be of the pointed type, while in another they may be rounded; and the same statement may be made with regard to the suboral avicularia. Within the limits of the same genus we may further notice that certain species have lateral avicularia, while others have suboral avicularia. Here, again, we find the same indifference as to the shape of the rostrum and mandible.

If we might provisionally suppose that the two kinds of avicularia constituted an allelomorphic pair, represented by Aa, and that the lateral and suboral positions indicated a second allelomorphic pair, Bb, the four combinations, AB, Ab, aB, ab, would be theoretically possible. We might, in other words, have pointed or rounded lateral avicularia, and pointed or rounded suboral avicularia. All these conditions actually occur in such genera as Lepralia and Schizoporella; and in some cases two species which agree in the form of the avicularia but differ in their position, or agree in the position but differ in their form, appear on other grounds to be nearly related one to the other.

Other cases may be taken from Retepora, an instance where we may feel ourselves on comparatively secure ground, since there are strong reasons for believing the genus to be a natural one. The genus as a whole possesses an almost bewildering variety in the form, position, and

[1] The case of the scutum is less striking than that of the other structures under consideration, since conditions intermediate between full development and complete absence are not uncommon.

size of the avicularia, among which, however, we may distinguish the following kinds:—(i) The suboral avicularium, closely related to the orifice and usually termed "labial," because it occurs on what may be described as the lower lip; (ii) frontal avicularia, on some part of that surface of the zoœcium which bears the orifice; (iii) basal or dorsal avicularia, on the backs of the branches; (iv) fenestral avicularia, which guard the edges of the fenestræ or meshes of the colony.

In many of the species of this large genus the suboral avicularia are of the small rounded type. In other species they are small and pointed, with an acute mandible; while others are distinguished by possessing suboral avicularia that may be described as gigantic.

Among the frontal avicularia similar differences exist. In one case that has come under my observation a remarkable variation of this kind is found within the limits of a single species. Remembering the great difficulty there often is in arriving at certainty with regard to the limits of the species in the genus under consideration, I wish to emphasise the fact that this instance is taken from *Retepora phoenicea*, a form that not only has well-marked specific characters of the ordinary kind, but is remarkable in having a beautiful carmine-red or violet colour, a respect in which it differs from most of its nearest allies. The frontal avicularia of this species are usually of the pointed type, but in the variety in question—a colony from Torres Straits—they are, so far as I have been able to ascertain,[1] all of the rounded kind.

The fenestral avicularia show a similar behaviour. In South Australian waters there are a number of forms which are regarded as varieties of *Retepora monilifera*. In the form known as var. *munita* there is usually a suprafenestral avicularium of large size, distinguished by having a rounded mandible, which is a good deal broader than it is long.[2] In another form of the same species, distinguished by MacGillivray as var. *acutirostris*, the *munita*-avicularium may either occur as such in some of the fenestræ, or be replaced in others by a large avicularium of the typical pointed form.

In other species a gigantic infrafenestral avicularium commonly occurs, but while these structures are found in a considerable proportion of the fenestræ of some colonies they appear to be completely absent in other colonies. In this series of cases, which is well illustrated by *Retepora phoenicea*, I think there is clear evidence that different colonies, from the same locality and belonging to the same species, may show the two conditions of presence and absence respectively of fenestral avicularia. According to the ordinary criteria by which species of Polyzoa are discriminated, it might be necessary to place these in different species—a result which is not supported by other evidence. I think we must conclude that a species may have the faculty of entirely dropping out some complete series of organs, like certain kinds of avicularia. The Mendelian principle may here come to our aid by showing the theoretical possibility of having the two conditions represented in a series of colonies of identical parentage. If this should really be the explanation of the facts, it should occasion no surprise if some members of the immediate progeny of a colony in which a certain type of avicularium is absent should be found to be provided with a complete armature of these appendages.

The cases so far considered may conceivably be explained on ordinary Mendelian lines by assuming that an entire colony is homozygous or heterozygous with regard to particular characters. Remembering that the so-called ancestrula, or primary individual, does not show all the characteristics of the mature colony, we must, however, assume that the determinants present in it do not find their full expression until the budding process has commenced.

But we are by no means at the end of our difficulties, even in considering the distribution of the appendages we have so far discussed. The instances already given have for the most part been cases in which an entire colony differs in certain respects from other colonies. We have still to notice the common case in which there are differences in different parts of one and the same colony. No theory can be considered complete unless it is able to account for these differences.

I approach this part of the subject with great trepidation, conscious as I am of the absence of experimental evidence for the suggestion I wish to make. This suggestion is, briefly, that if a segregation of characters normally takes place in the formation of the gametes of an organism, it is conceivable that an analogous segregation may occur in the blastogenic processes, or, in other words, in the formation of a bud. It may be asserted positively that there is a very definite differentiation of individuals at this time, not only in the Polyzoa, but also in other animals which increase by budding. The fact that some of these differentiations appear to be alternative suggests the possibility that they are due to a process which resembles the Mendelian segregation of determinants in the gametes.

One of the instances which appears to me specially suggestive in this connection is the genus Steganoporella, the species of which are remarkable for the dimorphism of their zoœcia. This dimorphism is expressed, as we have already seen, by differences in the opercula and in their muscles, and in the form of the orifices which are closed by the opercula. It is not too much to say that every individual in a Steganoporella colony belongs to one of the two types in question; and, so far as I am aware, intermediate forms of zoœcium do not occur. It is thus a positive fact that the blastogenic tissues undergo some sort of differentiation of an alternative character, and there is at present no reason for believing that the differentiation is in any way correlated with the production of sexual cells by either of the two kinds of zoœcia.

Another case which seems to me specially suggestive is that of the simultaneous occurrence in the same colony of two different kinds of avicularia. These instances are not confined to a few species, but may be found in a number of genera which do not constitute a single assemblage of related forms. The pointed and rounded adventitious avicularia may be scattered about promiscuously in the same colony, or even on the same zoœcium. Sometimes avicularia of one of the two types normally occur in a particular position, but are occasionally replaced by avicularia of the other kind, an example of a general phenomenon to which Prof. Bateson has given the name of "homœosis."

Excellent illustrations of this substitution may be taken from the genus Retepora. In the *R. monilifera* series already considered, the *munita* and *acutirostris* types of avicularia may occur in different fenestræ of the same colony. *R. granulata* usually possesses a labial avicularium and a frontal avicularium, both of the small rounded kind. In one of the colonies of this species dredged by the *Siboga* most of the labial avicularia are of this type, but a certain proportion of the zoœcia have a pointed labial avicularium. In another colony most of the *frontal* avicularia are small and round, but in some of the zoœcia they are large and pointed. In both instances the examination of the mandibles proved the reality of the distinction inferred from the shape of the calcareous parts.

Instances of a similar substitution could easily be multiplied, while the cases of the simultaneous occurrence of the two kinds of adventitious avicularia are innumerable. Without going so far as to say that intermediate conditions do not occur—a generalisation that could only be established by very prolonged study—it may certainly be maintained that it is the general rule for an avicularium to assume one of the two types. In a suitable preparation it is usually quite easy to sort all the mandibles into their proper group at first sight, and without having to pause to consider doubtful cases. This fact is surely significant, and it can at least be argued that in the blastogenic processes by which the avicularia have been developed some differentiation or segregation must occur by which the two kinds are constituted. If this differentiation should prove to be analogous to the segregation which occurs during the formation of gametes we should be able to account for much that is at present perplexing in the polymorphism of the Cheilostomata. We should in par

[1] It may be noted that it is extremely difficult and often impossible to make a study of every part of a large and irregular Retepore sufficiently exhaustive to justify one in asserting positively that all parts are identical in respect of their avicularia.

[2] This characteristic *munita*-avicularium is probably merely an enlarged form of the small circular type of avicularium met with as labial avicularia and in other positions in many species.

ticular not be precluded from regarding a colony with avicularia of one type as nearly related to other colonies which possess avicularia of the other type; and we should have some explanation of the fact that many of the genera possess all the different forms of avicularia which are variously distributed among their constituent species.

I have so far spoken as if the adventitious avicularia belonged to two types only. This statement requires some further qualification, although it may nevertheless be true that all the forms can be referred to one or other of the two principal kinds. As a matter of fact, a single Cheilostome colony may bear more than two sorts of avicularia; as, for instance, appendages with large pointed mandibles, in addition to two kinds of those with small rounded mandibles.[1] This introduces a further complication, about which it is unnecessary to speculate at present.

It may naturally be asked whether there are any numerical facts which support the suggestions I have made with regard to the significance of the different forms of avicularian appendages. I must admit that the numerical relations are so complicated and apparently so variable that I have not been able to draw any definite conclusion from them.

Experimental evidence is at present wanting, nor would it be easy to devise crucial tests. Even if it were possible to experiment with two colonies of the same species which differ in their avicularian appendages, the result might be negative, since it is not possible to say definitely whether the eggs of a given colony are normally fertilised by the spermatozoa of the same colony or by those of a different colony. Some light may conceivably be obtained from observations on the regenerative processes which may occur in Polyzoa. A recent Paper by Levinsen[2] gives some information with regard to this point, and there are a few other observations on the same subject scattered through the literature of the Polyzoa.

It is thus obvious that the speculations in which I have permitted myself to indulge cannot be regarded as more than a guess as to the significance of the causes which underlie the facts observed; but, whether the view I have outlined has anything to recommend it or not, the observations on which I have depended are, I think, correct. If this be the case, some explanation of the facts is urgently required. The decision of the principles on which the Polyzoa should be classified may not be a matter of immediate practical importance, but our theories of species cannot be regarded as established until they have shown themselves capable of explaining all the cases. Some modification of the Mendelian theory seems to me to be capable of elucidating the apparently haphazard way in which the several forms of avicularia are distributed in the species of Cheilostomata, and it may perhaps be allowed to afford a working hypothesis that can be used in systematic study. The results of such a hypothesis would, I think, be far-reaching. Whether we are justified in accepting it provisionally or not, I am convinced that we require some hypothesis by which we may regard two specimens as belonging to the same species, even though they may differ in what might at first sight seem to be fundamental respects. And, *vice versâ*, we require the liberty to regard two species as widely separated from each other in the system, even though they possess identical types of avicularia.

There are other questions which might have been considered in the Cheilostomata, and, in particular, the presence or absence of oral or marginal spines and the forms and distribution of the ovicells. The occurrence of the latter is, however, probably connected with the presence in the young zoœcium of tissue which will give rise to an ovary; and this implies the consideration of another factor which is very difficult to estimate.

[1] In the species of Retepora, for instance, there may occur the following types of avicularia, in addition to others that need not be mentioned: Conspicuously large avicularia, some of which are usually fenestral, either pointed ($a$) or rounded ($b$); small avicularia, either pointed ($c$) or rounded, these latter occurring as two well-marked types in which the mandible is respectively longer than broad ($d$) or broader than long ($e$). The following combinations may occur in individual species or colonies: $a+c+d$, $a+d+e$, $a$ alone, $b+c$, $b+d$, and others. Examples of some of these combinations may be seen in Busk's Report on the Polyzoa collected by H.M.S. *Challenger* (Part XXX., 1884).

[2] "Sur la Régénération totale des Bryozoaires," Acad. Roy. des Sci. de Danemark. Bull. de l'Année 1907, No. 4.

I must not conclude without at any rate referring to the fact that the Polyzoa are by no means the only animals in which dimorphism or polymorphism occurs as the result of blastogenic processes. But among the Cœlenterates, for instance, the occurrence of medusoid individuals cannot be considered apart from the question of the sexual cells. There is, however, one series of cases among Hydroids to which allusion may perhaps be made. I refer to the existence of pairs of genera such as Corymorpha and Tubularia, Syncoryne and Coryne, Podocoryne and Hydractinia, in each of which pairs the two genera are distinguished by the fact that one produces free medusæ while the other has sessile gonophores. There is already some evidence that the validity of these generic distinctions is open to question; and the free medusoid individual and the sessile gonophore might conceivably be related in such a way as to form members of an allelomorphic pair. The same phylum contains another striking example of dimorphism in the distinction between gastrozooids and dactylozooids in many Hydroids; while in the Siphonophora the differentiation of various forms of individual has advanced much further.

But I have already gone much beyond my evidence, and I must bring my remarks to a conclusion by expressing the view that the causes which regulate the differentiation of the individuals during the blastogenic development of the Polyzoa are well worthy of further study, and that our knowledge of the unity of the vital processes throughout the animal kingdom gives us reason to believe that they are part of some general Biological law.

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## SECTION E.

### GEOGRAPHY.

OPENING ADDRESS BY MAJOR E. H. HILLS, C.M.G., R.E., PRESIDENT OF THE SECTION.

THE thirty years that have elapsed since the British Association last met in this city of Dublin have seen an obvious and rapid progress in the science of geography, and a steady though perhaps not quite so apparent change in the character of that science.

In 1878 large parts of the earth's surface still remained untrodden by the feet of a white man; large areas were open to the enterprise and intrepidity of the explorer; large spaces were blank paper upon our maps. Now there is but little of the earth's surface absolutely unknown.

It is not my intention to detain you by any recapitulation of the work of these years to show you how and by whom these areas have been traversed and the gaps in our maps filled in. I intend rather to speak of the present and of the future work of the geographer, and to do this to any advantage we must at the outset recognise the change that has taken place in the nature of his task, and the fact that the days of individual exploration are over, never to return. We must recognise that sporadic, unorganised effort must be and is being replaced by organised, systematic work, and that the scientific traveller of the last century, with his rough map-making equipment, his compass, watch, and sextant has yielded his place to the scientifically equipped survey-party with their steel tapes, theodolites, and plane tables.

The theme is not a new one to this Section. I find on referring to the transactions of past years that in 1902, at the Belfast meeting, Sir Thomas Holdich, the President of Section E, said: "We find those spaces within which pioneer exploration can be usefully carried out to be so rapidly contracting year by year as to force upon our attention the necessity for adapting our methods for a progressive system of worldwide map-making, not only to the requirements of abstract science but to the utilitarian demands of commercial and political enterprise."

These words express succinctly the ideas that I wish to take as the text of my address to-day. I am, however, not ambitious enough to attempt to cover the whole surface of the earth in the brief review that I intend to put before you of the progress of scientific survey. Rather I wish to restrict our outlook to that section of the work in which we may all be considered as having a direct personal interest—namely, the survey of the British empire, especially those lands under the more immediate tutelage of the

Government of this country. Let it not be thought, however, that while we for the moment pay little attention to the regions lying outside this definition, we are supporting the fallacious idea that the survey of any part of the earth can be considered apart from the survey of the surrounding country. With the possible exception of the case of an oceanic island such an assumption would be an erroneous one. Our British empire is so widespread and our possessions are so often in close and intricate juxtaposition with those of other nations that there is in this work large scope, and indeed necessity, for international co-operation. Examples of this will occur to us in the course of our review. We shall thus see that in addition to the obvious connection which the geography of our empire has with that of other countries there is an even closer connection in the methods of manufacture of that geography, which methods we summarise under the general term of survey. One of the root ambitions of the scientific surveyor is to determine the exact figure of the earth, an operation for which observations spreading over a large area of the earth's surface are demanded. In fact, we may truly say that the problem of the earth's shape will not be completely solved until the whole surface is known to the surveyor. That is, therefore, pre-eminently a problem for international solution.

Before proceeding to the consideration of our special subject, the survey of the British empire, it will be interesting to interpose a few remarks on the questions of the utility and origin of national surveys in general. We may first note the somewhat curious fact that the production of a map of a country, useful as such a work is for many purposes, has almost always been embarked upon because the imperative necessity of maps of the theatre of operations in war has been brought home to the people and Government of a nation. Thus the ordnance survey of England had its first beginning in a military map of the highlands of Scotland, commenced in 1747, intended to facilitate the operations of the troops under the command of the Duke of Cumberland. It was not until many years later that the systematic triangulation of the country was undertaken, a work which was initiated partly for map making and partly for astronomical purposes. There was a consensus of opinion among astronomers that it would be greatly to the advantage of that science if the observatories of Greenwich and Paris could be connected by triangulation, and the famous French astronomer Cassini, in October, 1783, drew up a memoir to this effect. The arguments brought forward convinced King George III., and he granted a sum of money sufficient to enable the work to be started. This act of royal generosity was recorded by the surveyors in the following grateful terms: "A generous and beneficent monarch, whose knowledge and love of the sciences are sufficiently evidenced by the protection which he constantly affords them and under whose auspices they are daily seen to flourish, soon supplied the funds that were judged necessary. What his Majesty has been pleased to give so liberally it is our duty to manage with frugality consistent with the best possible execution of the business to be done."

It is worthy of remark that the junction of the triangulation systems of Great Britain and France was not made until 1861, and that the trigonometrical connection of Greenwich and Paris observatories has not yet been completed to the final satisfaction of men of science, a point which we shall have occasion to recur to later.

In France, we may note in passing, the starting of the triangulation had a quite different and quite definite object, the determination of the length of the metre. This unscientific unit of length was fixed as a fraction (1/10,000,000) of the quadrant of the earth's surface between the Pole and the Equator, and to find this quantity it was necessary to measure on the earth's surface as long an arc of the meridian as could be obtained.

In the case of our other great national survey, that of India, its origin is to be found in circumstances somewhat analogous. The Madras Government, owing to the success of the British arms in the Mysore campaign, found itself with a great accession of totally unsurveyed country in the middle of the Peninsula, while at the same time there were only in existence the roughest sketch-maps of the older possessions. It was apparent that if any map, of even approximate accuracy, was to be made covering a country of such vast area, it was imperative that the work should be prosecuted upon the most rigorous and strictly scientific basis. The general lines upon which it should be undertaken were laid down in February, 1800, by Brigade-Major Lambton, who addressed a letter to the Madras Government advocating a mathematical and geographical survey of the peninsula.

In this letter he discussed the principles upon which such a survey should be based. He dismissed astronomical fixations as not providing the requisite degree of precision, observing that such determinations of position are liable to great inaccuracies, "three, four, perhaps ten minutes," and proposed a triangulation emanating from a measured base line checked by similar base lines at intervals. He recognised that the figure of the earth and lengths of the polar and equatorial radii were not then known with the precision necessary for fixing the spheroidal co-ordinates of the trigonometrical stations of a survey covering such a large area of the earth's surface, and that a geodetic survey was therefore necessary *pari passu* with the geographical survey. He had an impression, how derived it is not now possible to say, that there was a sudden abnormal diminution of the force of gravity at the latitude of 10° north, and consequently that "a degree on the meridian from that parallel to the Equator must be very short compared with a degree to the northward of 10°." He observed that it would be necessary to "attend to this circumstance," which he characterised as important both from the map-making and from the rigorously scientific point of view. He added: "I shall rejoice, indeed, if it should come within my province to make observations tending to elucidate so sublime a subject."

In a similar case, occurring in recent years, the outcome has not been so satisfactory. It will be within the recollection of all here how at the time of the South African war the public at home learnt with shocked surprise that there were no maps in existence of a colony which had been under the British flag for a long period of years. To those who knew the facts this was, naturally, no matter of surprise; but it was earnestly hoped by many that this grave deficiency thus revealed by the stress of war would be remedied by quiet work in the time of peace, and that, at the conclusion of the military operations, the foundation should be laid for a federal survey department of British South Africa comparable with, though on a more moderate scale than, the Survey Department of India. This hopeful scheme, which it may be recorded very nearly came to fruition, ultimately found political conditions too adverse, and had to be indefinitely postponed. An army engaged in field operations in the north of Natal now, or, in fact, at any time for an indefinite number of years in the future, would find the country nearly as mapless as it was found by Sir R. Buller in 1900.

In this short recital of the determining causes which have in the past led to the initiation of national surveys, it will have been noticed that no allusion has been made to what we should now perhaps consider the main utility of a map—namely, its value for all purposes connected with the ownership, development, and taxation of land. When the ordnance surveys of Great Britain and Ireland were originated there was little thought of this use, and it was not until long after that period, when the enormous deficiencies of the existing property plans were revealed by the Tithe Commutation Acts and by the railway boom, that the value of a national survey for preparing a cadastral or large-scale property map of the country was recognised and acted upon. Now this is often the ostensible object for embarking upon a regular survey. It is fully recognised that, especially in the case of a country undergoing rapid development, which is fortunately true of many of our oversea possessions, the provision of an accurate land map is of prime necessity both to the private or corporate landowner and to the State.

Neither were any of the early surveys undertaken for the purpose of mutual delimitation of international boundaries, a necessity which has in recent years been the stimulating cause for many pieces of valuable survey work, especially in Africa.

The other manifold uses of a map are familiar to all of you, and we need not pause to enumerate them. We may admit the fact that the adequate mapping of its territories is recognised as one of the duties of a civilised State. Let me now turn to the main subject of this address—the inquiry as to how far this duty is performed by us, what shortcomings we can perceive, and what suggestions we can offer for the future.

Two years ago this task would have been a difficult and laborious one. Now it is greatly facilitated by the issue from the Colonial Office of those excellent little volumes, the reports of the Colonial Survey Committee.

This body has been in existence since August, 1905, and has published three annual reports. The Committee is therein defined as an advisory one formed at the instance of the Secretary of State for the Colonies to advise him in matters affecting the survey and exploration of British colonies and protectorates, more especially those in tropical Africa. It is not at present an executive body, that is to say, it has at its own disposal no grant of public money or other funds; whether it will ultimately develop into such is a question that the future alone can answer. Even thus limited in scope and powers it has, however, already worked a notable improvement—firstly, by laying down authoritatively some of the more salient conditions that ensure the efficient and economical expenditure of whatever funds may be available, and by pointing out the disastrous extravagance of unsystematic and unmethodical work; secondly, by insisting upon uniformity where uniformity is essential, such as in matters relating to the style, projection, scales, and sheet-lines of the maps produced, while leaving the utmost latitude as to methods, these being selected in each case to suit the very divergent nature of the country met with. It results from this that any two small portions of the map of Africa, say, for instance, one sheet of the dense forest region of the Gold Coast and another of highland country of East Africa, though 3000 miles apart and executed at different times by a different staff, will match each other in general character, and will ultimately be found to fit exactly into their places as constituent parts of a great map of the country. Thirdly, we may reckon the mere fact of publicity in these matters as of no mean advantage. Though, as in the case of many other Government publications, this report is not as widely read as its merits deserve, yet it is all to the good that the information is there ready and available for anybody who has the curiosity to consult it. I therefore welcome the opportunity of directing your attention to this volume.

In entering upon the discussion on the survey of British Africa, the first point that meets us is the geodetic basis of the whole work; upon what do the actual positions depend? In other words, to put the matter more familiarly, how are we to provide that every isolated piece of the map will exactly fit into its proper place? The only method for ensuring this is by basing all our surveys, ultimately, upon a skeleton or framework of geodetic or primary triangulation executed with the utmost attainable precision. Such a skeleton, or rather backbone, will eventually exist in Africa in the shape of the meridional arc, or chain of triangles, along the thirtieth meridian, running right through the country from north to south, and ultimately joining on to the great arc observed by the famous astronomer Struve. This originally extended from the mouth of the Danube to Hammerfest, in Norway, an amplitude of $25\frac{1}{2}°$ of latitude. To prolong it southward, passing up the Nile Valley, through the heart of tropical Africa, across the Zambezi River, and terminate it at the southernmost point of the continent, is a magnificent conception due to Sir David Gill, to whose energy and enterprise the actual execution of considerable sections of the undertaking must also be ascribed.

At the present time the chain has been completed from the south to within seventy miles of the southern end of Lake Tanganyika, a distance of about 1700 miles. At Lake Tanganyika it will enter into German territory. The German Government, fully recognising that the project is not only of great theoretical interest, but also of immediate practical value, are already taking steps to start work on their own section, from the south of Tanganyika up to the parallel of 1° south latitude. From 1° south, northward to about $1\frac{1}{2}°$ north, the arc lies near the boundary between the Congo Free State and the British Protectorate of Uganda. An International Commission is at present engaged in the survey of the boundary region, and Sir D. Gill, ever ready to seize an opportunity of forwarding the work he has at heart, succeeded in raising sufficient funds, partly from the Treasury, and partly by grants from a few leading scientific societies, to enable an observer to be sent out with this Commision to carry the arc over this section. North of this point the line comes into the territory of the British Soudan, and traversing this eventually reaches Egypt proper. Here it comes into the charge of Captain H. G. Lyons, the director of the Survey Department of Egypt, under whose care its interests are safe.

It will thus be seen that while the actual completion of the whole chain is as yet somewhat remote, we are in the satisfactory position of being able to say that, so far as the section lying on the continent of Africa is concerned, there is no portion of which there is not a reasonable probability that it will be finished within a measurable period. With regard to the section joining Africa and Europe the position is not so happy. This will run through Palestine and Asia Minor, and therefore lies in Turkish territory. It is not likely that the Turkish authorities either will or could carry out such a work; in fact, seeing that even when completed it would be totally useless to them, it would be hardly reasonable to expect them to do so. It must, therefore, presumably be a matter for international cooperation. One point may be mentioned with regard to the exact route of this connecting section. Sir D. Gill, in his Report on Geodetic Survey of South Africa, 1896, said: "By an additional chain of triangles from Egypt along the coast of the Levant, and through the islands of Greece, the African arc might be connected by direct triangulation with the existing triangulation of Greece, and the latter is already connected with Struve's great arc of meridian which terminates at the North Cape in latitude 71° N. The whole arc would then have an amplitude of 105°." This, however, gives rather a poor connection with the European triangulation. The South Albanian series has a much higher average error than either Struve's original work or any part of the African series. This portion would consequently be a weak link in the geodetic chain, and it would be better to avoid it altogether by carrying the line along the coast of Asia Minor to Constantinople, and then up the east side of Turkey to the mouth of the Danube.

When we look back a few years and call to mind the prominent part that this country has taken in the survey of Palestine—I need only mention in this connection the names of Kitchener, Warren, and Conder—we cannot avoid a feeling of regret that we are not ourselves in a position to take the whole execution of this section of the line upon our shoulders. I am too well aware of the many urgent claims upon the Treasury to suggest that it is possible that they would be prepared to incur such a charge; but supposing, for the moment, that part of the necessary funds could be provided from other sources, I think we may fairly urge that it is our duty to contribute a substantial monetary grant towards the furtherance of an end so desirable and so practically useful.

The difficulty of obtaining money for geodetic work, the benefit of which is not immediately apparent to the man in the street, is notorious. Thus Sir T. Holdich, in 1902, said: "But this accurate framework, this rigorously exact line of precise values which ultimately becomes the backbone of an otherwise invertebrate survey anatomy, is painfully slow in its progress and is usually haunted by the bogey of finance. It does not appeal to the imagination like an Antarctic expedition, although it may lead to far more solid results, and it generally has to sue *in formâ pauperis* to Government for its support." To account for this regrettable, but undoubtedly true, fact two reasons may be adduced. There is, in the first place, the possible ignorance as to the ultimate value of the work; but, secondly, and perhaps not least, there is the fear, not entirely unjustified, that to satisfy the demands of the scientific man is something akin to the operation of filling a sieve with water. It has been so often seen that compliance with one demand only leads to another being made, that we may well sympathise with the holder of the public purse when he draws the strings tight and refuses to pay for an arc along the thirtieth meridian in the fear that directly this is completed he will be asked to pay for one along the twentieth meridian, and then along the tenth, and so *ad infinitum*. It behoves us, therefore, as practical men to make sure that our demands are reasonable and limited to the actual requirements of the case, and where such limits cannot be set we should make this fact clear at the outset. When, however, it is possible to set such limits, we should not hesitate to do so; and in the case of the African arc this latter course is fortunately possible.

If we take the map of Africa we shall see that the arc along the thirtieth meridian passes through, or near, all the colonies of British South Africa, close to British Central Africa, or Nyasaland, through Uganda, and is thus connected with British East Africa, through the British Soudan and through Egypt. There remain absolutely untouched by it only the West Africa colonies—Nigeria, the Gold Coast, Sierra Leone, and the Gambia. These latter will eventually get their geodetic framework by an extension southwards of the French triangulation of Algeria, a work of a high order of precision. We are therefore entitled to say—and I take this opportunity of saying it with all due emphasis—that with the exception of some triangulation to join the West African colonies with the French triangulation, the arc along the thirtieth meridian is the only primary triangulation required for the adequate mapping of the whole of British Africa. The remainder of the geodetic framework can be supplied by ribs of secondary triangulation branching out from the main backbone, such as the line already completed along the boundary between British and German East Africa, passing to the north of the Victoria Nyanza and thence westward to the thirtieth meridian.

You will observe that I here speak only of the triangulation required for mapping purposes, not of that demanded by the geodesist for the study of the figure of the earth. The latter is satisfied only with a survey of the highest attainable precision covering as large an area of the earth's surface as possible, or at all events with arcs, both meridional and longitudinal at frequent intervals. It cannot be other than a very long period before the whole of Africa is surveyed upon this scale of accuracy, and in the meantime we must devote ourselves to the far more urgent duty of mapping the country, leaving the more remote and abstract task to our descendants, well satisfied if in our hands the foundations have been well and truly laid.

Furthermore, as we shall see presently, if we are prepared to recognise as a national duty the minutely precise survey of our own land and of all territories under our flag—and I do not see how any reasonable man can withhold this recognition—then there are duties of this nature lying closer to our hands than any to be found in Africa.

Having thus passed in brief review the ultimate geodetic basis of our African surveys, let us enter more into detail and glance at the actual survey work now in progress in the different regions of the continent.

In British South Africa, as we have already noted, the political conditions are at present unfavourable to any comprehensive scheme of operations. There is, however, in progress a first-class topographical survey of the Orange River Colony and a reconnaissance survey of Cape Colony. The former is an excellent example of the class of work that can be done by a small military party of the highest technical training working upon systematic lines, and I should like to devote a few minutes to a short description of the methods adopted and of the results obtained.

The survey party consists of two Royal Engineer officers and four non-commissioned officers, the former undertaking the triangulation and the general supervision of the field work, and the latter the plane tabling. The positions are primarily based upon the points of the geodetic survey broken up into a secondary triangulation with sides averaging ten miles. In 1907 the average triangular error of the secondary work was 2·9 seconds of arc, and the greatest linear errors of displacement, as tested by the geodetic triangulation at the end of a chain forty-five miles long, were three feet in latitude and two feet in longitude. The probable error of a trigonometrical height was under a foot. You will see, therefore, that the accuracy is ample for all mapping purposes, even upon large scales, and the degree of precision is in excess of that demanded for a topographical map on the scale of two miles to an inch. The rate of progress and the low cost of work are, however, no less notable than its accuracy. The actual rate of out-turn is about eight square miles per day per man, or for the whole party twenty-three square miles of detail survey per diem, and the number of trigonometrical points fixed about three hundred per annum. The cost works out to about eight shillings per square mile of the completed map, and the whole area of 47,000 square miles will be finished, printed and published, in five and a half years.

These remarkable results are due in a large measure to the energy and organising power of the officer in charge, Captain L. C. Jackson, R.E. The detail survey is done in sheets fifteen minutes square, each non-commissioned officer being given one complete sheet, which he works at until finished. Four such sheets are therefore in progress at any given time, and each sheet takes about six weeks. Seeing the rapid rate of progress maintained, it might perhaps be thought that the country is a particularly easy one for the topographer. Such is, however, by no means the case. It is true that there is an entire absence of the surveyor's greatest impediment, large areas of dense forest, but there is much broken and difficult country, rising in places to altitudes of above 7000 feet.

In Cape Colony the reconnaissance survey is of a somewhat similar character, but owing to the large area of the country and to the small amount of money available the work has perforce to be of a more rapid nature. In Natal, Bechuanaland, and Rhodesia no survey is at present in progress.

Passing northward through Africa, we come to the British Protectorate of Nyasaland, formerly called British Central Africa. Of this country a certain number of maps exist purporting to give topographical detail; but as they are not based upon any framework of triangulation, and as much of the detail only depends upon rough sketches, it is impossible to say how far they can be accepted as correct representations of the ground.

It is most unfortunate that financial considerations prevent the execution of any systematic trigonometrical survey. The absence of such, and the fact that maps are being made which must inevitably be withdrawn and replaced by others in the future, will undoubtedly be the cause of ultimate waste of money.

Passing northward again we come to the large and important protectorates of British East Africa and Uganda, in both of which systematic surveys are in hand. The geodetic framework is supplied by a triangulation along the Anglo-German boundary, connected with chains of triangles along the railway in the neighbourhood of Nairobi. In Uganda proper there is also a triangulation covering a substantial area. As already noted, all this work will eventually be tied into the thirtieth meridional arc, though it is not likely that the final adjustment of geodetic positions thus arrived at will necessitate any substantial alterations upon the maps.

In both protectorates topographical surveys are in hand, and maps on the scale of two miles to an inch will be issued. In British East Africa, under the able direction of Major G. E. Smith, R.E., rapid progress is being made. This topographical mapping is additional to the cadastral maps also in progress in both countries. These latter are required for property purposes, in Uganda for demarcating the estates given over to the native inhabitants of the country under the agreement of 1900, and in East Africa for attachment to title-deeds of lands alienated for farming or stock-raising.

In the Soudan the enormous area of the country—more than a million square miles—and the limited funds available have prevented any systematic survey being taken up. A large amount of reconnaissance mapping has been done, and a series of sheets on the scale of 1/250,000 (four miles to an inch) have been published. These are corrected and improved by officers and Government officials as opportunity offers. The energies of the Survey Department are almost entirely spent in meeting urgent local requirements in the shape of cadastral maps of the cultivated areas along the river.

Somaliland, a British protectorate which came into unfortunate prominence a few years ago, is a country of too small value to be worth the cost of any sort of survey, and the only maps that exist are based upon the route sketches of travellers and sportsmen and upon the work done by a small section of the Survey Department of India during the military operations five years ago.

Leaving the east side of Africa and turning our eyes westward, we may note that in the colony of the Gold Coast a rigorous survey was rendered imperative by the gold-mining boom of 1901. The work was entrusted to Lieut.-Colonel Watherston, C.M.G., R.E. Owing to the dense forest covering practically the whole country triangulation would have been prohibitive in price and very slow in execution. The initial positions were therefore fixed by a network of long traverses, executed with all possible refinements with steel tapes and theodolites. Astronomical latitudes were observed by Talcott's method at every fifty miles. The errors of misclosure of the traverses proved to vary from about 1 in 2000 in unfavourable cases to nearly 1 in 6000—results inferior to triangulation, but at the same time sufficiently accurate to form the basis of a map with no appreciable errors *on the paper*. One great defect of the traverse method of fixing points lies in the practical impossibility of carrying the heights through without occasional checking, either by lines of levels or by trigonometrical observations. Such work makes, therefore, an imperfect basis for topography, and would only be used when natural features compel its adoption.

Northern Nigeria is a country of enormous area, and, up to the present, of small revenue. It has therefore not been found possible to allocate the funds for any systematic mapping. The existing maps are compilations based upon sketches made by civil and military officers when travelling upon duty and upon the surveys made by the different Anglo-French and Anglo-German boundary commissions. In 1905–6 Captain R. Ommaney, R.E., fixed the astronomical longitudes of fifteen towns by exchange of telegraphic signals with Lagos. With the aid of these values, combined with a number of astronomical latitudes, it has been possible to combine the material into something like a complete map. It need, however, hardly be pointed out that astronomical fixations are liable to large and uncertain errors, due to the variation of local attraction, and cannot attain the precision of even a rapid triangulation. In Southern Nigeria the experience has been somewhat unfortunate. This colony has spent a very substantial sum upon its survey department, and if the work had been properly organised and systematically carried out we should by now be in possession of a complete map of a large portion of the country. Unluckily, the mistake has been made of detaching survey parties for non-geographical purposes, such as the erection of telegraph lines, work doubtless urgently required in the interests of the colony, but not lying within the sphere of a survey department. Thus systematic progress was rendered impossible, and, though isolated pieces of triangulation and long lengths of traverses have been done, no topographical map of any area yet exists.

Of the remaining West African colonies the Gambia river is a narrow piece of land with boundaries running parallel to the river banks, and, except for the actual trade along the river, is unimportant. In Sierra Leone the country in the immediate vicinity of Freetown was surveyed by the colonial survey section, a small party employed by the War office for the purpose of making surveys of places of special military importance. The map of the remainder of the colony is a compilation based on miscellaneous material.

In the course of this summary of the state of the mapping of British Africa mention has been made of the surveys made by joint commissions appointed for the delimitation of international frontiers. No small part of the existing map is due to work of this class. Thus joint Anglo-French commissions have marked out the frontiers of the Gambia, Sierra Leone, the Gold Coast, and Nigeria; Anglo-German commissions the eastern boundary of Nigeria, the boundaries between British and German East Africa, between German East Africa and North-East Rhodesia from Lake Nyasa to Tanganyika, and between Bechuanaland and German South-West Africa; Anglo-Portuguese commissions the frontiers between Portuguese East Africa and North-East Rhodesia and Nyasaland respectively. Useful surveys have also been made in the course of the mutual demarcation of the frontiers between Abyssinia and the Soudan on the west and British East Africa on the south; also of the frontier between the colony of Sierra Leone and the Republic of Liberia.

Important as the work done by these commissions has been, its value would be greatly enhanced if the reports of each commission were published in a succinct and easily accessible form. Such reports would naturally contain a record of the actual frontier as finally ratified, and also a technical account of the survey methods employed. They would thus be of permanent use both to the official or officer on the spot for the easy settlement of any disputes that may arise, and to the chief of any future boundary commission as an aid to the selection of the methods of survey most suitable to the particular country with which he is concerned.

Up to three years ago many of the African protectorates were under the tutelage of the Foreign Office, while the older colonies were under the Colonial Office. The reports of Boundary Commissions are therefore scattered through official documents in the two offices, and are drawn up upon no uniform model. Now that the superintendence of all these territories has been handed over to the Colonial Office, and that body has set itself such an excellent example in the appointment of the Colonial Survey Committee and the publication of its reports, it is greatly to be hoped that they will follow up the good work and systematise and publish all these Boundary Commission reports. If a model for such a publication is desired, I may refer to the account of the demarcation of the Turko-Egyptian frontier between Rabah on the Mediterranean to the Gulf of Akaba, lately issued by the Egyptian survey.

The account which I have endeavoured to give you, short and imperfect as it is, of the present state of the mapping of British Africa will have shown you clearly that there is a large amount of excellent work now in course of execution, and that there has been, especially during the last few years, very considerable progress made towards coordinating this work and towards maintaining certain fixed standards of accuracy, rapidity, and economy.

It will naturally occur to you to inquire whether this coordination could not advantageously be pressed a step further, and whether all the isolated survey departments, now working in the various colonies and protectorates, could not be amalgamated under one executive head; whether, in fact, a Survey Department of Africa, precisely analogous to the Survey Department of India, could not be formed. The advantages of such a step are obvious, but must not be allowed to blind us to the difficulties. We have, in the first place, the objection to be met that the South African colonies would, in present circumstances, almost certainly refuse to join in any general scheme, and would not consent to any arrangement whereby money raised in one colony would be spent outside its own geographical limits. If, however, we leave South Africa out of the question, the financial difficulty tends to disappear. Both our East and West African possessions are, in general, not yet in a position to maintain themselves, and are still, and will be for some time to come, partially supported by grants from the Imperial Treasury. To divert a portion of these grants to pay for the maintenance of a survey department would only be a matter of account, and could be adjusted so as to cause no hardship to any one colony. There remains the geographical difficulty of space. The fact that the heads of the department would have to keep in close personal touch with countries differing entirely in character, and perhaps three months' journey from each other, does not appear to offer any insuperable objections, and I cannot avoid expressing the hope that it may be found possible at a no very remote date to take some steps in the direction of a consummation which appears so desirable.

In giving my evidence before the Royal Commission on the War in South Africa, presided over by Lord Elgin, I outlined the general features of a scheme under which the Imperial Government would undertake the topographical mapping of all our oversea possessions, apart from self-governing colonies. As on this occasion I was considering the whole question more exclusively from the military side, no reference was then made to the question of cadastral maps, and it was tacitly assumed that these would fall to be constructed by the land office or a land survey department belonging to each separate colony. On the present occasion we are not restricted to the military point of view, but are permitted a wider outlook. Our task is to consider the map in all its aspects, both as regards its method of construction and its ultimate use, whether for military, administrative, engineering, or purely scientific purposes. This enlargement of our scope does not, I think, modify our previous conclusions, and were I now called upon to devise a scheme for the mapping of British Africa, I should base it upon the principle of a central Imperial body for executing the triangulation and topography, leaving the land survey to local organisations.

The arguments in favour of this policy are manifold. As regards the triangulation they hardly require stating. It will be obvious to all that such work must be closely coordinated, and that some central, directing head is imperatively called for. The enormous waste of money that is ultimately involved by tolerating imperfect work, of which many examples could be cited, is alone a sufficient justification for holding this view. We may, however, pause to examine a little more closely into the advantages of centralisation as regards one particular operation in a survey. That is the measurement of the initial base line upon which the accuracy of the whole framework depends. This task used to be one of the most laborious and difficult with which the surveyor is confronted. The apparatus employed, some form of compensation bar, was cumbrous and difficult to use, the site selected had to be levelled, and the preparatory alignment carried out with the most scrupulous care. Thus the Loch Foyle base for the triangulation of Great Britain and Ireland was about six miles long, and the actual measurement, quite apart from the time spent on the preparation of the ground, took sixty days, an average rate of work of just more than 500 feet per working day.

A few years ago the discovery was made of the nickel steel alloy with a very small or zero coefficient of expansion, the so-called invar. This valuable metal, by abolishing the necessity for any temperature correction, has enormously simplified all physical measurements of length, and, *à fortiori*, those measurements, such as base lines, which are perforce done in the open air and over a large range of temperature. Survey bases are now measured with an invar wire stretched to carefully regulated tension, and either laid along a flat trough, or what appears to give equally good results, hung freely between supports. The gain in precision due to the avoidance of errors of expansion or contraction in the measuring apparatus is substantial, while the gain in rapidity is very great. Thus, as a contrast to the Loch Foyle base, let me give a short account of the measurement of a base in Spitsbergen by the Russian party of the joint Swedish and Russian missions in 1900, extracted from a review already written for the *Geographical Journal*.

The conditions for accurate work were very unfavourable: no site even approximately flat could be found, and the base was therefore irregular in contour and traversed rough and in some parts marshy ground. The weather conditions were far from ideal. The cycle of operations was as follows: An auxiliary base 175 metres long was measured with Struve's apparatus, twice before the main base measurement and twice afterwards. The two wires used for the main base were standardised on this subsidiary base four times, twice before and twice after use. The main base, 6·2 kilometres long, was measured twice in each direction by each of two wires, eight measures in all. The limit of error in the final value was 17 millimetres—say, one part in 360,000.

The whole of these operations, including the laying out of the standard and the comparison of the wires, were completed in a period of three weeks; Monsieur Backlund, who superintended the actual measurement, left the observatory at Pulkowa on June 11 and returned to it on July 24. It was therefore possible to standardise the wires not only by the check base upon the spot, but also by the permanent standards of the observatory within three weeks of their use for the actual measurement. It need hardly be pointed out that this was eminently favourable to the attainment of the highest exactitude, and we have here a marked example of the value of centralisation. The proposed trigonometrical survey department of Africa would probably find it advantageous to adopt similar procedure, and, instead of trusting a base measurement to a local staff unacquainted with the work, it would send out one or two men of highly trained technical skill equipped with the best apparatus. The money spent in journeys would be more than saved—firstly, by the unquestionable gain in accuracy and the consequent avoidance of the costly necessity for repeating bad work; and, secondly, by the gain in time, due to the fact that the local staff would not be called upon to learn the use of an unfamiliar set of instruments.

Similar advantages would arise from a partial specialisation of the angular measurements. Thus the first-class observer with a theodolite must possess certain qualities of eyesight, health, and judgment, rarely combined in one individual. When such a combination of qualities is found it should be made the best use of, and a good man should not be wasted on second-class work. At present, upon the system of regarding each colony as an isolated unit, it is not possible to employ every man to the highest advantage, and there are doubtless many examples at present in Africa of able men being set tasks much below the standard of their ability, and, *per contra*, men of no such qualifications being given work beyond their powers. It is only by working with an extended organisation, employing a large staff and responsible for a large area of country, that any approximation can be made towards that ideal wherein every member of the establishment is used to the best advantage according to his special qualifications.

To turn from the triangulation to the question of topography, we shall find analogous arguments in favour of entrusting this work to one central department. Whether we consider the necessity for a uniform system of training for the topographer, or whether, looking at the matter from the other side, we consider the desirability of a close degree of uniformity in the resulting map, we arrive at the same end. Nor need we confine ourselves to theoretical arguments; practical results are before us as examples. It is not possible at the present moment to point out a single case of a thoroughly satisfactory topographical map of any country whatever which has not been executed by men trained in a properly organised survey department or, what is equivalent, in the Corps of Royal Engineers. Examples of failure to accomplish this are numerous. Thus we have the cases of the British Colonies in South Africa before the war; of Canada, where no topographical map existed until two years ago, when the work was taken up by the military department; and of Ceylon, where, in spite of the vast sums spent on survey and the small size of the island, no topographical map of the slightest pretensions to completeness exists of any part of the country.

It may also be noted that, especially in the case of a developing country, it is of enormous advantage that the map shall be begun and finished within some reasonable time. If a long interval elapses between the commencement and the completion, the first sheets are out of date before the last are done, and the whole exhibits a most undesirable lack of uniformity.

With a central organisation the mapping of each protectorate can be taken up in turn and dealt with rapidly, thus producing a homogeneous map impossible to a small local body. Upon the converse point, the question as to whether our central department should or should not undertake cadastral survey, the arguments are perhaps not so one-sided. It is, however, quite clear towards which side the balance of advantage tends. Taking into account the intimate connection of the cadastral survey with the system of land holding and land taxation, the fact that these systems necessarily vary and that as a financial matter of account the receipts and expenditure of each colony are separate, it is not difficult to see that the land survey is better left to local control. This would not preclude any particular colony from arranging with the central body for the execution of any definite piece of work of this class, upon terms agreeable to both sides, in a similar manner to that in which cadastral survey is executed by the Indian survey for provincial Governments, and it need hardly be pointed out that the geodetic points fixed by triangulation would in any case be available as a framework for the large-scale map.

The geographical survey of the British Empire, apart from Africa, will not on this occasion detain us long. I exclude from present consideration the great self-governing colonies—Canada, Australia, and New Zealand—and also the whole country lying within the sphere of the survey of India. Ceylon has an elaborate land survey system; and though, owing to past mistakes, the geographical mapping of the island is in a most lamentably backward condition, there are good grounds for hope that this state of affairs will be remedied in the near future. The Malay States, where, owing to the fertility of the soil and the ubiquity of rich tin ore, the land values are high, have the basis of an excellent survey system, and possess a backbone of triangulation which will eventually extend southward to Singapore, and possibly northward to join the Indian series in the south of Burma. Hong Kong, including the leased territory on the mainland, is of small area and of no appreciable geographical importance. It has been adequately mapped for military purposes. Of our insular possessions, Mauritius, St. Helena, and (in the Mediterranean) Cyprus and Malta are thoroughly surveyed. The other islands scattered throughout the ocean which fly the Union Jack, including the West Indies, while their coast lines have naturally been the subject of close attention by the Hydrographic Department of the Admiralty, are, as regards their internal geographical features, still quite imperfectly known. The large and important territory of British Guiana is entirely unsurveyed, and indeed in part almost unexplored.

You will thus realise that if we are prepared to admit the validity of the premiss that the mapping of its own territory is an imperative duty of a State which aspires to justify itself before the nations as the possessor of a world-wide Empire, there is still plenty of employment for the scientific geographer in the British dominions.

Having thus far spoken of our duties and obligations, for such they appear to me, which lie abroad in countries remote from our own shores, let us now turn our eyes inward and see if we cannot discern some similar duties lying close to our hands.

I take it that the great majority of us have been brought up in the idea that our own Ordnance Survey is of such a high order of accuracy that a proposal to undertake a revision of the fundamental triangulation of the British Isles must appear strange. Yet this idea will not be a new one to the British Association, for two years ago at the York meeting I brought the subject before this Section in a short note, which gave rise to a useful discussion.

What I shall say now will be in a large measure a repetition of my previous remarks, a repetition for which I need offer no apology, as it will be apparent to you that had any steps been taken to remove this standing reproach to British geodetical science no recurrence to the subject would be called for. As matters stand, however, I feel impelled to recur to it with increased emphasis, a position in which I am confident of being supported by all those who earnestly care for the scientific repute of our country. Some few years ago, at the request of the International Geodetic Conference, a volume was prepared by General Ferrero, the eminent Italian geodesist, giving a summarised account of all the geodetic surveys of the world. If we take this volume and examine the relative degree of precision of the different national surveys there enumerated we shall find that Great Britain stands lowest on the list.

The popular illusion, for it is really no other, as to the extreme accuracy of the triangulation of the British Isles rests in no small degree upon what must be considered a fortuitous circumstance—namely, the accidental smallness of the closing error. Have we not all been told how at the conclusion of the triangulation, when the observations had been carried from the primary base on the shore of Loch Foyle across part of Ireland and across Wales and England, terminating in two points on Salisbury Plain, the distance between these points was calculated, using as data the measured length of the Loch Foyle base and the observed angles of the triangles across the country? The distance between the same two points was then measured with every refinement of accuracy, and the measured length compared with the calculated length. The difference between them was found to be twenty inches. If in traversing a large portion of the kingdom the aggregate error only amounted to this minute quantity—minute, that is, compared with the distances involved, how can we either expect or demand a better result, even if the work be re-done with the most refined methods that the accumulated experience of the last fifty years can suggest?

To answer this question we must bear in mind that the closing error of a piece of work such as a triangulation is not the only, nor indeed the best, test of its precision. A small closing error may be due to accident; larger discrepancies may have occurred at intermediate stages which have chanced nearly to cancel themselves at the end. Such undoubtedly did happen in this case. The work was not as accurate as the smallness of the closing error would seem at first sight to imply. We have, however, in such a case an absolute measure of relative precision in the magnitude of the average triangular error, being the quantity by which the sum of the observed angles of a triangle exceeds or falls short of the true value of 180° + spherical excess.

From this we can readily deduce the "probable error" of a single observed angle, a form in which the measure of precision of a triangulation is often expressed.

In our British survey this quantity equals 1·20 second of arc, while in good modern work it does not in general exceed 0·25 second. Making due allowance for the fact that the network of triangles over our islands is a complicated one, and therefore that the ultimate precision is considerably greater than that of a chain of triangles of the same order of individual accuracy, we are probably justified in concluding that a re-survey would at least halve the final errors.

Such a re-survey is urgently demanded in the interests of international geodesy.

It will of course be clearly understood that this implies no adverse criticism upon the work of the men who originated and carried out the primary triangulation of the British Isles. For that great achievement we must all have the most sincere admiration. It was pioneer work of the highest order; it set a standard of accuracy never before attained, and was for long taken as the model for such work in other countries. It was, however, started at the end of the eighteenth century, and was completed in 1857. It is therefore hardly surprising that it falls somewhat short of the precision of modern observations of the same class. It will also be understood that this re-survey does not affect the question of the trustworthiness of our Ordnance Survey maps. Any errors which exist in our triangulations are important only for geodetic discussions, such as the determination of the exact figure of the earth, and are quite negligible for map-making purposes. There can be no appreciable error from this cause upon the maps of our own country, even those on the largest scales, and no question of reconstructing our maps can arise. This is fortunate from the financial point of view. Such a reconstruction would involve a very heavy expenditure, while the cost of the re-triangulation suggested would be quite trifling compared with the actual annual expense of our national surveys.

The result of this inferiority in accuracy of the British survey is that it is useless to coordinate it with the Continental series for geodetical purposes. This defect is all the more noticeable in that the necessary observations for joining up the two series were actually made. Three stations on the coast of Kent—St. Peter's Church, between Margate and Ramsgate; Coldham, a hill about two miles north of Folkestone; and Fairlight, a hill about four miles north-east of Hastings—were connected trigonometrically with three stations in France—Montlambert, near Boulogne; St. Inglevert, over the village of Wissant; and the Clock Tower at Gravelines. This was done in 1861–3. The observations were of a high order of precision. It would not be necessary to repeat them.

The importance of the coordination is apparent when we inspect a map of Europe with the neighbouring part of Africa, upon which the triangulation lines are entered. We then see that the British part of the work is imperatively required to extend, and in fact to complete at one end in each case, two important geodetic arcs, viz., the meridional arc along the meridian of Greenwich and the longitudinal arc along the latitude of 52° north. Without the British portions these arcs extend from Ain Sefra in Algeria to Gravelines in France, an amplitude of 18°, and from Orsk in Russia to the same point in France, an amplitude of 57°. With the British section added they would be further extended to Saxavord, the northernmost point of the Shetland Islands, and to Valentia, on the West of Ireland, respectively. The added amplitudes would be 10° and $11\frac{1}{2}$°, very material additions, which would undoubtedly prove of substantial scientific value.

It will thus be seen that it is by no means necessary, or even desirable, to re-observe the whole network of triangles covering our islands. All that is required is to connect geodetically the three extreme points—Saxavord, Valentia, and the stations on the Kent coast just mentioned.

A knowledge of the exact figure of the earth is of high scientific importance, especially so in reference to recent speculations as to its possible deviation from a spheroidal form. It cannot be other than a subject of national shame that so important a link in this research remains unfilled. We may note with gratification the forward position that our nation has in the past taken in the advancement of geodesy. We know the great work done in the triangulation of India, and we have alluded to the magnificent conception of the Cape to North Sea arc due to Sir David Gill. Surely it is not asking too much that we should take steps to set our own house in order, and to ensure that our own triangulation is at least as accurate as that covering the neighbouring portions of the continent of Europe. The subject is one upon which the powerful influence of the British Association might legitimately be brought to bear, and any representations from our body would come with a peculiar appropriateness from this the Dublin meeting, seeing that so large a section of the work, the importance of which we wish to urge upon the Government, lies upon Irish soil, the execution of which would therefore devolve naturally on the Ordnance Survey of Ireland.

In concluding this address I feel constrained to apologise for what may have appeared to some of you the dull and unromantic character of my theme. I am too well aware that to many the idea of geographical advance is confined to the perilous traversing of virgin lands, to the navigation of unknown waters, and to the penetration of forests or deserts never yet trod by white men's feet. I am conscious that the substitution of the surveyor for the explorer has necessarily destroyed much of the old romance, and that the feelings born when any fraction of the earth's surface was for the first time opened to our ken can never be revived. While, however, the romance has gone, the dangers remain, and there is as much call now for unflinching courage and for unselfish devotion to duty as there was in the days when the search for the sources of the Nile was an impelling cause sending adventurous men into the unknown. Whether occupied in cutting his way through the almost impenetrable forests of the Gold Coast or struggling with the papyrus swamps of the Nile basin, or whether, standing upon the top of some old volcanic hill, he is engaged in scanning the blue distances of the great Rift valley, the surveyor is not less worthy of your admiration than the earlier traveller whose name is perhaps honourably enshrined in that of river or mountain. Whether pushing his way through the jungles of the Malays or floating upon the muddy stream of an African river, whether he is braving the attacks of savage animals, of treacherous natives, or the far more insidious assaults of the germs of some deadly disease, he is equally deserving of your sympathy and your encouragement. He is in truth a shining example of the power of that spirit of adventure and thirst for information which has carried our race so far in the past, and which in the future is, we all trust, destined to lead us ever "upwards and on"; the spirit that esteems no sacrifice too great in the cause of duty, and recognises no duty so high as that of making some contribution towards the increase of natural knowledge.



## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—A course of nine post-graduate lectures on "The Scientific Principles of Radio-telegraphy and Radio-telephony" will be given by Prof. J. A. Fleming, F.R.S., at University College on Wednesdays, beginning October 14. The introductory lecture will be addressed to a general audience, and no charge for admission is to be made. Cards of admission must, however, be obtained beforehand by those attending. The succeeding lectures will be free to graduates of the University and to undergraduates in their third year who may be qualified to take advantage of them. A fee of two guineas for the course will be charged to all other persons. Those desirous of attending the course should apply to the secretary, University College, Gower Street, W.C.

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THE Rev. W. Lower Carter has been appointed lecturer in geology at the East London College.

PROF. JOSEF MOELLER, of Graz, has been appointed to the chair of pharmacognosia at the University of Vienna.

THE foundation-stone of a new college for the training of teachers was laid at Dudley on Thursday last by the Countess of Dudley. The cost of the building (which will accommodate 100) is 19,000*l*.

CLASSES for the instruction of miners are being started at Hamstead by the Staffordshire County Council, which will, it is hoped, enable many miners who possess sufficient practical knowledge, but who lack the necessary scientific and other training, to fill higher positions in the mines.

THE new municipal college at Portsmouth was opened on Thursday last by the Mayor of the town. The building, which is the outcome of a scheme for higher education organised by the local education authority, is an adaptation of the best ideas of the principal technical institutes of the country to the requirements of Portsmouth, and is stated to be in its equipment one of the most modern in England.

THE following arrangements have been made for the opening of the winter session of certain of the medical schools. At Guy's Hospital (in connection with the Physical Society), Sir R. Douglas Powell will deliver an address on October 8 entitled "Just Procedure of Medicine"; Dr. Charles Slater is to speak on October 1 at St. George's Hospital on "The Laboratory in Medical Education and Practice"; on the same date an address will be delivered at the Middlesex Hospital by Dr. A. M. Kellas; at King's College Hospital Prof. Alexander MacAlister, F.R.S., will deliver an address on October 1; Sir Edward Fry, F.R.S., is to speak at University College Hospital on October 2. At St. Mary's Hospital, on October 1, an address is to be given by Sir John Broadbent; Dr. Harrington Sainsbury is to speak on the same day at the London School of Medicine for Women; at the West London Post-graduate College an address is to be given on October 13 by Sir R. Douglas Powell; Dr. R. Jones is to speak on "Insanity, Wit, and Humour" on October 1 at the Polyclinic; at the North-East London Post-graduate College Mr. Jonathan Hutchinson, F.R.S., is to speak on October 8; Sir T. Clifford Allbutt, K.C.B., F.R.S., is to give an address at the University of Manchester, on October 1, on "Hospitals, Medical Science, and Public Health"; and at University College, Bristol, on October 1, Sir Rubert Boyce, F.R.S., is to speak.

THE approaching winter session in our technical colleges and schools is being heralded by the publication of numerous attractive and carefully compiled year-books and prospectuses of the various institutions in London and the provinces. We have received a number of these helpful guides, and, without exception, they provide intending students with valuable assistance in the choice of classes and hints from experienced teachers as to how to plan courses of work likely to be of service in various industries. Among recent syllabuses published in connection with London institutions we notice those of the Northampton Polytechnic Institute, the Sir John Cass Technical Institute, and the East Ham Technical College. At the Northampton Institute there are provided for next session day and evening courses in mechanical and electrical engineering, technical optics, horology, and artistic crafts, in addition to numerous other classes in a varied selection of subjects. The recent provision of increased accommodation obtained by the occupation of the British Horological Institute not having been found sufficient for the requirements of this institute, an additional building is being erected in the courtyard, and it is hoped that the greater part of it will be available immediately after Christmas. It is interesting to observe that in the technical optics department there will be classes for kinematograph operators in continuation of the pioneer classes last session. In these classes an attempt is to be made to safeguard the holding of kinematograph exhibitions by giving a practical training to the operators in charge of the apparatus. At the Sir John Cass Institute the instruction is devoted especially to technical training in experimental science and in the artistic crafts. Graded curricula of study, extending over several years, are provided in pure and applied chemistry, metallurgy, art metal work, jewellery, enamelling, bronze casting, and chasing. Full courses of study are also provided in drawing, design, and modelling in connection with these crafts, drawing and modelling from living animals being a special feature. In addition to the evening classes at the East Ham College, conducted in eight departments and intended to supply the particular educational needs of the district, there is a well-staffed secondary school for boys and girls.

## SOCIETIES AND ACADEMIES.

### LONDON.

Royal Society, June 25.—"The Spectrum of Scandium and its Relation to Solar Spectra." By Prof. A. **Fowler.** Communicated by Sir William Crookes, F.R.S.

(1) The arc spectrum of scandium consists of two distinct sets of lines, which behave very differently in solar spectra. Each set includes both strong and faint lines.

(2) Lines belonging to one set correspond with the enhanced lines of other elements, notwithstanding that they appear strongly in the ordinary arc spectrum:—(*a*) these lines are very feeble or missing from the arc-flame spectrum, and are strengthened in passing to the arc, the arc in hydrogen, or the spark; (*b*) they occur as relatively strong lines in the Fraunhofer spectrum; (*c*) they are weakened in the sun-spot spectrum; (*d*) they occur as high-level lines in the chromosphere.

(3) The remaining lines show a great contrast when compared with the first group:—(*a*) they are relatively strong lines in the arc-flame; (*b*) they are very feebly represented in the Fraunhofer spectrum; (*c*) the stronger lines are prominent in the sun-spot spectrum; (*d*) they have not been recorded in the spectrum of the chromosphere.

(4) The special development of the enhanced lines in the Fraunhofer spectrum, together with their presence in the upper chromosphere, indicates that the greater part of the scandium absorption in the solar spectrum originates at a higher level than that at which the greater part of the iron absorption is produced.

(5) The discussion of scandium lines indicates that while in the case of some elements solar identifications are to be based chiefly on arc lines, in others it is the enhanced lines which may be expected to show the most important coincidences.

(6) The flutings which occur in the arc and arc-flame do not appear when the arc is passed in an atmosphere of hydrogen. As suggested by Thalén, they are probably due to oxide of scandium.

Tables are given which show the lines of the arc spectrum from 3930 to 6580, the positions of the oxide flutings, and comparisons of the principal lines of the two classes with the sun, sun-spots, and chromosphere.

### PARIS.

Academy of Sciences, September 7.—M. Bouchard in the chair.—Vortices in the solar atmosphere: H. **Deslandres.** The filaments (the *long flocculi* of Hale) are considered to be vortices with horizontal axes, parallel to the surface, and traces of the effects of these are to be found right across the face of the sun. Six diagrams showing the alignment of these on the sun's surface at different dates are given. Similar effects may be expected on the earth, and the application of the theory here developed to the problems of terrestrial meteorology may give interesting results.—The new Marehouse comet: M. **Giacobini.** Observations were made on September 3, 4, and 5. The apparent positions of the comet are given on these dates, together with the mean positions of the comparison stars. The comet shows as a rounded nebulosity of about 15″ to 20″, with a badly defined nucleus. A small tail, with a position-angle of 250°, can be distinguished.—The law of Stokes and the Brownian motion: Jean **Perrin.** The force opposing the motion of a sphere in a viscous liquid has been calculated by Stokes as a function of the viscosity of the fluid, the radius of the sphere, and its velocity. From experiments with emulsions of gutta, the author shows that this law is verified for spheres having a radius of about a tenth of a micron. The assumption of the applicability of this law, made by the author in his previous work on this subject and criticised by J. Duclaux, is thus shown to be well founded.—The fixation of acetophenone on benzoylacrylic acid: J. **Bougault.** Von Pechmann has shown that boiling solutions of alkalies decompose benzoylacrylic acid into glyoxylic acid and acetophenone. In the cold the reaction is different, some diphenacylacetic acid being produced. The yield of the latter acid is increased if some acetophenone is added to the alkaline solution, and the author gives reason to suppose that a direct condensation between the acid and the ketone takes place under these conditions.—The ages of the basalts in the neighbourhood of Massiac, Cantal: P. **Marty.**—The existence of transported strata in the north-east of Algeria: L. **Joleaud.**

## CONTENTS.

THURSDAY, SEPTEMBER 24, 1908.

## *RADIO-TELEGRAPHY.*

*Radio-Telegraphy.* By C. C. F. Monckton. Pp. xvii + 272. (London: A. Constable and Co., Ltd., 1908.) Price 6*s.* net.

ONE of the greatest triumphs of the school of philosophy founded by Bacon is, doubtless, the discovery and theoretical and experimental development of electromagnetic oscillations. In this, as in most other matters in the science of electricity, the foundation stone was laid by Faraday, in his conception that the medium between electrically charged bodies, and between bodies carrying electric currents, was the seat of the strains and stresses set up by the said electrical disturbances. The subsequent development is, nowadays, common knowledge. It will suffice to refer simply to Maxwell's mathematical formulation, in 1873, of Faraday's conceptions, and the hypothesis that the electromagnetic strains in the medium travelled at a definite speed, depending on the permeability and specific inductive capacity of the medium.

The next great step forward was the brilliant experimental demonstration of electromagnetic waves which Hertz made about the year 1890. There is no doubt that Hertz was the true discoverer of radio-telegraphy. True it is that the range of his transmission was only a few yards; nevertheless, he was the first man to transmit signals over a distance by means of electromagnetic waves. Hertz, however, worked for science and not for telegraphy, and it remained for a host of inventors to adapt the newly-discovered phenomena to practical use. Prominent among these latter is the name of Marconi. The great achievement made by him was in 1896, when, experimenting for the British Post Office, he constructed his oscillator, or transmitter, by carrying a conducting wire high into the air as one arm, whilst he connected the other arm to earth.

Since then a large number of improvements and developments have been made under Marconi's auspices, and this country certainly owes him its thanks for the energy and perseverance which he has put into pushing forward into practical use what is certainly one of the greatest applications of modern science. However, very many other eminent inventors and men of science have done a vast amount of work in bringing this new industry to its present state of relative perfection. Among these should be mentioned Lodge, Braun, de Forest, Muirhead, Fessenden, Fleming, Slaby, Arco, and others. One of the most recent, and what will probably be one of the most important, steps forward has been taken by Poulsen. In the musical arc Duddell had utilised the earlier discovery of Elihu Thomson, that electric oscillations could be produced by shunting an air gap in a continuous current circuit, with capacity and inductance, and he was thus able to produce frequencies of 50,000 per second, which were, however, too low to admit of radiation. Poulsen, by using an arc struck between carbon and copper electrodes, in an atmosphere of hydrogen, has obtained frequencies of 1,000,000 per second, and thus the possibility of radiating into space a continuous undamped train of waves has been attained.

As was, perhaps, not unexpected, the commercial exploitation of an industry developing at the rate this is doing has been attended with a certain amount of friction and recrimination. A short time ago it seemed possible that progress might be prevented by a radiotelegraphic war, due to the commercial rivalry between the Marconi and the combined German interests. Fortunately, however, the Governments of all the principal countries of the world have made a satisfactory agreement which came into operation on July 1 of this year. One of the things which the conference of 1906 did, and which will appeal perhaps to the man in the street, is that they standardised the name of the new method of communication, the official designation of the new system being that used as the title of this book.

Mr. Monckton is to be congratulated on having written a very interesting and valuable book, and the publishers likewise on the good style in which it is produced, and on the many excellent illustrations. The book contains a general exposition of the principles underlying the subject, together with a description of a large amount of the apparatus and methods used by the various companies. We would like specially to felicitate the author on chapters ii., iii., and iv., where, without the use of mathematics, he has given a really brilliant description of the properties of electric waves.

Authors of such books as this have a natural desire to start right at the beginning of their subject, and, as Mr. Monckton is not an exception to this rule, he has devoted chapter i. to an explanation of the elementary principles of electricity and magnetism. We are rather afraid that if an absolute layman were to take up the book his understanding of the same would not be greatly helped by this first chapter. Nevertheless, it serves as an appropriate introduction to the volume, and will perhaps be useful to those engineering readers whose elementary scientific ideas are apt to get a little rusty in the rush of modern business. In fact, we think this book will especially appeal to those engineers and scientific workers who are busily engaged upon some other branch of the profession, and yet laudably desire to know what progress this young and very lusty addition to the family of industrial applications of science is making.

To conclude this notice, reference must be made to chapter x., which deals with measurements in radiotelegraphy. It is a commonplace remark that electricity is a science of exact measurements. With the advent of radiotelegraphy it was found that hardly any of the instruments hitherto used were suitable for making measurements of the very high-frequency currents used. As a consequence, a considerable number of very ingenious instruments has been invented. The principles underlying many of the measurements, for example, of that all-important one—the measurement of wave-length—are identical. The measuring instrument consists of a circuit of variable self-induction and capacity. It is brought under the electric influence of the circuit to be tested, and by varying the self-induction and capacity the testing instrument is tuned to resonate with the vibration to be measured. The right point is shown, for instance, in the Fleming cymometer, by the point of maximum glow in a vacuum tube. From the known capacity and self-induction of the instrument, at this point, its oscillation constant can be calculated, and, therefrom, the wave-length obtained. For a description of these very interesting instruments and other valuable information we must, however, refer the reader to the book itself.

C. C. G.

## *THE SENSES OF INSECTS.*

*The Senses of Insects.* By Auguste Forel. Translated by Macleod Yearsley. Pp. xvi+324; two plates. (London: Methuen and Co., n.d.) Price 10*s.* 6*d.* net.

COMPARATIVE psychology as a science is beset with more difficulties than most of its kindred natural sciences. One of the greatest of these difficulties is that man, a creature gifted with the most highly developed intelligence, endeavours to interpret and explain the actions of the lesser intellectually endowed members of the animal kingdom from their standpoint. However much he may endeavour to avoid assuming an anthropocentric attitude, he must invariably find himself seated again on his pedestal of intellectual preeminence. He cannot avoid it; it is the only criterion he possesses. This difficulty is never more apparent than when an effort is made to study the manifold activities of that most active of the animal groups, the insects, and especially those families in which social habits have attained such a high state of perfection. In the study of the senses of insects we are necessarily compelled to form inferences from our own sensory experiences, and the result is that we not only cannot obtain an adequate conception of their ordinary sensory powers, but are completely baffled by many organs of an undoubted sensory nature.

Dr. Forel's work on this subject is not so well known in this country as it deserves to be. This, no doubt, is due largely to the fact that most of it has been published in rather out-of-the-way journals. Those students whose interest in the subject has been stimulated by Lord Avebury's work will be grateful to Mr. Yearsley for having performed this "labour of love," as he describes his translation.

The direct translation and publication *in toto* of a series of writings of such a nature, however, has its disadvantages. The present volume contains writings which date from the year 1878 to 1906. We have, therefore, not only the author's natural changes of opinion, but also mistakes, in fact, which have been brought about by the gradual growth of entomological inquiry. For example, in the section on hearing, the author states that "only crickets and several other Orthoptera appear to perceive sounds," which, in the light of more recent work of Mayer, Child, and others on the acoustics of certain nematocerous Diptera, is not quite correct. Nor does the author devote sufficient attention to the thoracic and crural tympanal organs of the Orthoptera, so well described by Graber, and of insects of other orders. To a present-day student of entomology a book on the senses of insects is incomplete without fuller reference to the morphological aspect of the subject, notwithstanding the lack of experimental studies. The author truly says, "for the human and animal brain, as well as for its functions, it demands that we shall use anatomical, physiological, biological, and psychological methods." The presence in insects of many problematic organs, which from their histological structure and connections appear to be of a sensory nature, such as, for example, those associated with the halteres of Diptera and the various chordonotal organs which have been described, does not detract from the difficulties which confront the student of these problems. The author pays little attention to these problematic organs, and, in view of the absence of experimental work on them, he is no doubt wise in not discussing them in the absence of facts, as some writers on the subject are accustomed to do. Where he treats with the senses of sight and smell he is more at home; his experiments are very interesting and valuable, and some of his results conclusive; it is in the description of these experiments that the value of the book lies rather than in his, in places, extensive polemical references to some of the work of others.

The last chapter, on judgment, mind, and reflexes, is one of the most interesting. The author is of the opinion that plastic reaction is primary, and that instinctive or automatic activity which predominates in the insects is secondary. He does not think that instinct can proceed from inherited habits, but that the automatism of all nervous activity, whether by selective heredity or individual habit, is a secondary phenomenon derived from primitively plastic habits, and in support of this he refers to the plastic origin of the slave-making instinct of the species of Formica.

We venture to think that the book would have been improved had the translator dispensed with a detailed account of the author's earlier work, the essentials of which might have been incorporated in the account of his later work; or had the author brought these earlier writings up to date with regard to our present knowledge of the morphological aspect of the problem, its value to the general reader would have been considerably enhanced thereby. With the exception of sub-œsophageal ganglion (p. 5) where supra-œsophageal is surely intended, and Chalcidites (p. 140) for Chalcidides, there are few mistakes of nomenclature in the work.

C. GORDON HEWITT.

## *FORESHORE PROTECTION.*

*Coast Erosion and Foreshore Protection.* By John S. Owens and Gerald O. Case. Pp. 148. (London: The St. Bride's Press, n.d.) Price 7*s.* 6*d.* net.

THIS book consists principally of a reprint of papers on foreshore protection read before various societies, and of articles contributed to magazines.

Although it does not deal in such a comprehensive way with the subject of coast destruction and protection as the book on "The Sea Coast" published by Messrs. Longmans about six years ago,[1] it contains a great deal of practical information that should be of great service to those interested in coast protection.

One of the authors is the son of the late Mr. Case, so well known for the very successful work he carried out in protecting and saving from destruction the coast land at Dymchurch, and afterwards for his advocacy of the system of low groynes.

The book is divided into fourteen chapters, dealing respectively with forces acting on coasts and the sea bed, transporting power of running water, movement of materials composing the foreshore and bed of the sea, causes of erosion, protection works, materials of construction, groynes, sea walls, sand dunes.

The authors very properly point out that there is no one method of protection that can be applied to all coasts, but that each shore must be considered on its merits, and that it is only after due consideration has been given to the special circumstances which may influence the effect of the sea upon any particular shore that the proper remedy can be designed.

By way of example, it has been frequently said that it is useless to erect groynes upon a foreshore where there is no material to collect. But there are other matters that require consideration besides the actual collection of material. On many sandy coasts low groynes may serve a useful purpose by preventing denudation and the formation of swills and lows.

With regard to the sometimes debated question of high and low groynes, the writers of this book are fully in accord with the author of "The Sea Coast" in advocating the use of low groynes both on account of efficiency, convenience, and economy. With regard to the direction to be given to groynes, the authors do not see any reason for departing from a direction at right angles to the shore, and the majority of the engineers who gave evidence before the Royal Commission on Coast Erosion were of the same opinion, although some stated that, as a matter of experience, they had found the best results were obtained where the groynes were directed away from the side from which the prevailing winds came.

As to the proper distance between groynes, this has been found by the experience of the authors to be the distance between high and low water mark, or practically the length of the groyne. Experience has fully shown that the carrying up of the groyne from low water to about half tide level, as practised in many instances by the late Mr. Case, is not sufficient, as the water is apt to work round the end and make gullies, but that in every instance the groynes should extend so far as the high spring tides reach.

The chapter on ferro-concrete groynes contains much useful information on the application of this material to sea defence work, and gives illustrations and cost of works carried out for the protection of the coast of Sussex. The cost of these groynes is given as twenty shillings a foot run, which compares favourably with timber.

1 "The Sea Coast, Destruction, Littoral Drift, Protection." (London: Longmans and Co., 1902.)

## OUR BOOK SHELF.

*The Discovery and Settlement of Port Mackay, Queensland.* By H. Ling Roth. Pp. viii+114; 82 figs., 4 maps and charts. (Halifax: F. King and Sons, Ltd., 1908.)

PORT MACKAY in Queensland was discovered by Captain Mackay in 1860. The town was founded in 1862, and declared a port of entry in 1863, and is now the chief seat of the sugar industry in Queensland. The early history of a colonial settlement is sometimes of great interest, but it is often impossible to recover it, excepting where, as fortunately is usually the case in Australia, the young town promptly establishes a local newspaper. Port Mackay had the advantage of including amongst its residents Mr. H. Ling Roth, the author of the standard work on the aborigines of Tasmania; he was at one time secretary of the Mackay Sugar Planters' Association, and in this volume gives a monograph of the history of the town up to 1867, whence the story is continued in the columns of the local Press. He describes the discoveries along the Queensland coast up to 1844, and the exploration of the coastal districts by land from 1813 to 1859; and he explains how it happened that so valuable a locality as Port Mackay was missed by all explorers until 1860.

The volume is most valuable as a contribution to the historical geography of Australia. It includes a collection of portraits and interesting sketches of the early settlers. It tells several good stories, as of the sarcastic Mackay magistrate, who, when joined on the bench by a distrusted local J.P., asked his colleague whether he appeared for the plaintiff or the defendant. In the appendices, Mr. Ling Roth gives a valuable account of the aborigines of the district and of its natural history. He objects to calling the blackfellows aborigines, as he holds that Australia was first occupied by a negroid people who have been supplanted by the present race. This view, well known from its adoption by Sir William Flower, appears to be now generally discredited, owing to the lack of evidence in its support. The author undertakes a forlorn hope in his objection to Australian lizards being called Iguanas—often abridged to "Goanas"—because they do not belong to the genus Iguana as now restricted. The name may conveniently be retained popularly for the lizards formerly included in the Iguanidæ, and it is not so incorrect zoologically as those of "native bear" or native "cat."

There are specially interesting notes on the habits of some of the snakes and of the crocodiles, and the author appears disposed to throw doubt on the established habits of crocodiles of other continents from the different behaviour of the sluggish Queensland *Crocodilus porosus*.

Stories are often told of the wanton extermination of the Australian aborigines by the colonists. It is interesting, therefore, to learn from Mr. Roth that a collector on the coast from 1863 to 1873 endeavoured in vain to get an aboriginal skeleton for a well-known European museum. His failure shows that at least in the Port Mackay district there is no truth in the legends about the wholesale shooting of the aborigines.

J. W. G.

*Through the Depths of Space.* A Primer of Astronomy. By Hector Macpherson, jun. Pp. viii+123; illustrated. (Edinburgh and London: William Blackwood and Sons, 1908.) Price 2s. net.

IN this small primer the author has attempted to give an outline of all the main features of the solar system, comets and meteors, and the stellar universe. As a journalistic collation the result is not without merit, but as a "primer," presumably for persons previously unacquainted with astronomy, we fail to recognise the need for, or the suitability of, it. Having attempted too much in too little space, the author is in places forced to be dogmatic, in others he is inexplicit, and the beginner will find tabular statements which, without external assistance, will puzzle him.

To a fair extent the book consists of quotations from well-known writers fitted together with such statistics as one usually finds in popular articles; where the writer's personality appears, we find either dogmatic statements or information which is too loosely or too briefly explained. For example, on p. 28 the reader is told that in 1882, 1893 and 1905, "the disc of the sun was covered with spots"; the subsequent explanation of spot zones will but tend to confuse the beginner. In the next paragraph we read that Sir Isaac Newton showed that if "light" be passed through a prism, a band of coloured light, "known as the solar spectrum," is produced, a statement which can only convey the truth when the beginner either assumes, or knows, that it was the light of the sun that Newton employed. These examples will suffice to show that, in attempting too much, the author has occasionally lost sight of the fact that he was intending to write a book for beginners. Seven reproductions of celestial photographs and drawings illustrate the volume, some of them being from Prof. Max Wolf's beautiful originals.

W. E. ROLSTON.

## LETTERS TO THE EDITOR.

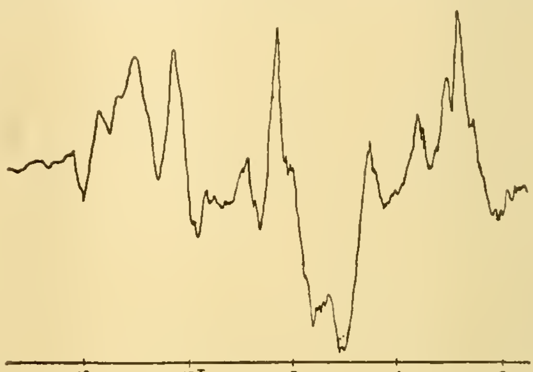
*[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.]*

### Large Magnetic Storm.

ON September 11–12 a large magnetic storm was experienced at Kew. There were minor disturbances earlier in the month, from September 4–6 and from September 8–10, and the magnetic traces were by no means absolutely quiet when the storm began. The commencement is, however, clearly indicated in the horizontal force curve (not reproduced). Starting at about 9h. 47m. p.m. on September 11, there was a very sudden change in the force. The movement of the horizontal-force magnet was of a type which not unusually ushers in large storms, but it was exceptionally large, representing an increase of about 112 $\gamma$ in H ($1\gamma \equiv 0{\cdot}00001$ C.G.S. unit) in less than two minutes of time. At the end of this movement H had reached its maximum during the storm. The first movement was followed by oscillations. A very rapid fall exceeding 300 $\gamma$ took place between 11h. 35m. p.m. and midnight, followed by an equally rapid but smaller recovery. The other principal changes in H occurred between 1 a.m. and 2 a.m., and between 4.40 a.m. and 6 a.m. on September 12. Between 4.40 a.m. and 5.7 a.m. there was a fall of 300 $\gamma$. The extreme range was not shown on the curve, which went off the sheet, but it exceeded 500 $\gamma$. Later on September 12, between noon and 7 p.m., there was further disturbance of a much less striking character, but this was probably from a distinct origin, and the storm commencing on September 11 may be regarded as terminating about 9.30 a.m. on September 12. On this view, the immediate result was a diminution of about 100 $\gamma$ in the value of H. Such temporary depressions in H are the usual legacy of magnetic storms, but the depression in the present instance seems above the average.

The declination curve, of which a tracing is reproduced on a reduced scale, shows the commencement about 9.47 p.m. on September 11 much less prominently. A small but sharp upward movement, representing an increase of about 1′ in westerly declination, is, however, visible, followed in the course of the next twelve minutes by an easterly movement of about 13′. The most salient features are the four peaks or turning points, where a prominent movement to the west terminated, and was followed by a similarly prominent movement to the east. The approximate times answering to these peaks are 11.4 p.m. and 11.44 p.m. on September 11, and 1.46 a.m. and 5.14 a.m. on September 12. The extreme easterly position was reached at about 2.53 a.m., and the extreme westerly position at about 5.14 a.m. on September 12, the total range of declination being about 1° 27′. The movements on September 12 were the most rapid. Between 1.24 a.m. and 1.46 a.m. there was a westerly movement of about 51′, followed in the course of the next eight minutes by an easterly movement of about 35′, while between 2.58 a.m. and 3.28 a.m. there was a westerly movement of about 53′. There were no large movements after 6 a.m.

The vertical force disturbance was of a somewhat unusual type. Whilst there was a certain amount of oscillation, the principal feature was that during the whole duration




September 11. Kew Declination. September 12.

of the storm—from 9.47 p.m. on September 11 to 9.30 a.m. on September 12—the vertical component, V, was depressed below its normal value. The extent of the depression may be judged from the fact that from 11.45 p.m. on September 11 to 6.10 a.m. on September 12—*i.e.* for more than six hours—V did not rise to within 150 $\gamma$ of the value which it possessed when the storm commenced. By 9 a.m., however, on September 12, V had returned to its normal value. Owing to loss of trace, the extreme range of the vertical force disturbance was not recorded.

C. CHREE.

Observatory Department, National Physical Laboratory, September 14.

### Bouvet Island and the Solar Eclipse of 1908 December 22–23.

A QUESTION having been raised as to whether the total phase of this eclipse will be visible at Bouvet Island, I have asked the Hydrographic Department for the most trustworthy coordinates of the island with the view of a settlement of the matter.

The position adopted for Bouvet Island on the Admiralty chart of the region is 54° 22′ S., 5° 21′ E.

Adopting the elements of the *Nautical Almanac*, the eclipse of next December for this position is a partial one, the magnitude (sun's diameter = 1) being 0·988. The island is about 10′ south of the southern limit of the zone of totality.

A. M. W. DOWNING.

H.M. Nautical Almanac Office, September 17.

### Ruthless Extermination.

HAVING noticed in your issue of September 3 a most interesting article on the subject of the extermination of animals in Africa, I cannot say how indignant I feel that there should be persons who actually advocate the wholesale destruction—by international consent—of the many wonderful species which have been built up in their perfection during countless ages of evolution.

How happy should I be if the news were conveyed to me, that the man who is the ringleader of this diabolical scheme had himself fallen beneath the vengeance of a lion or a crocodile.

Even if there were sufficient proof that the sleeping sickness is propagated by the large mammals and reptiles, there are many other means of checking it besides the extermination of these animals. The increase of various birds should be encouraged which devour the flies which propagate the disease, and every other means should be taken of a reasonable character.

Although I recognise the undisputed fact that the wild species of Africa must be kept in due bounds in the more thickly populated districts, I am convinced that every State of that vast continent, should never cease to preserve a sufficient number of all the indigenous local species, and that in the near vicinity of all the principal towns national parks should be established for the preservation of these wonderful forms of life; so that future generations may not be deprived of the pleasure of beholding them.

RALPH DE TUNSTALL SNEYD.

Fairview, Leek, Staffs, September 8.

### Instincts that are not Inherited Memories.

IF, as is not improbable, the presidential address to the British Association has the effect of reviving the dying embers of the use-inheritance discussion, it may not be out of place at this juncture to direct attention again to the fact that it is *impossible* to regard some of the instincts of insects as inherited memories.

Not only do the instincts of the neuters among the social Hymenoptera stand like a "lion in the path," but there are the less prominent but equally important section of instincts connected with oviposition, where, as in the case of some spiders, the female protects her eggs *after* deposition, with no possibility of the action being transmitted to the offspring so protected.

A bug, *Tectocoris lineola*, var. *banksi* (Don.), is recorded by Mr. Frederick F. Dodd (Transactions of the Entomological Society, 1904, pp. 483–5) as protecting its egg patch, laid on twigs of its food plant, by standing over them for a period of three weeks.

Females of some species of Psychid moths block the entrance of the larval case, which serves both as a puparium and place to deposit the eggs, with their bodies after depositing their ova.[1] Various species of Hymenoptera carefully block the entrance to the burrows where their eggs are laid, &c.

A. BACOT.

154 Lower Clapton Road, N.E., September 8.

### Meteors and the Comet.

SEPTEMBER 13, 8h. 32m., mag. 1, rapid, streak, $343^\circ+26^\circ$ to $332\frac{1}{2}^\circ+12^\circ$. Radiant, $71^\circ+52^\circ$.

September 14, 9h. 19m., mag. 1, slowish, yellow, $336^\circ+38^\circ$ to $330\frac{1}{2}+48^\circ$. Radiant, $343^\circ+24^\circ$ or $347^\circ+15^\circ$.

On September 14, at 9 p.m., the comet was seen at Bristol in a 2-inch field-glass just north of 50 Cassiopeiæ as a misty patch, perhaps about equivalent to an eighth-magnitude star.

W. F. DENNING.

Bristol.

### Meteors.

THE observation of meteors forms one of the most attractive branches of astronomy. No instruments are needed. The observer only requires patience, a pretty good eye, and experience, which, of course, must be learned.

Meteors fall on every night of the year. The sky may be lit with the moon, it may be murky, it may be cloudy, but still there are the meteors going on unceasingly. For every one seen by human eyes there are no doubt thousands, probably tens of thousands, unseen. Yet this branch, involving as it does star-gazing pure and simple, is a most attractive one, and in the bright years of the future it will no doubt occupy a very prominent place.

Bristol. W. F. DENNING.

[1] "Brit. Lepidoptera," Tutt, vol ii., p. 367.

## SURVEYING FOR ARCHÆOLOGISTS.[1]

### III.

*Instruments for the Measurement of Magnetic Azimuth alone.*

THE most inefficient instrument to employ in measuring magnetic bearings is the ordinary mariner's compass, showing the compass points only.

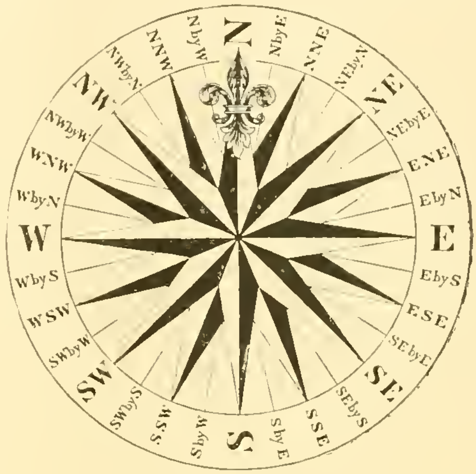



FIG. 7.—The "points" of the mariner's compass.

But there are now mariner's compasses available in which the bearings are stated in degrees, and in many ways, the degrees running from N. and S. to E. and W., and so on. The best form of card, however, is represented in Fig. 8, in which the degrees run from N. through E., S., W. to N. again.

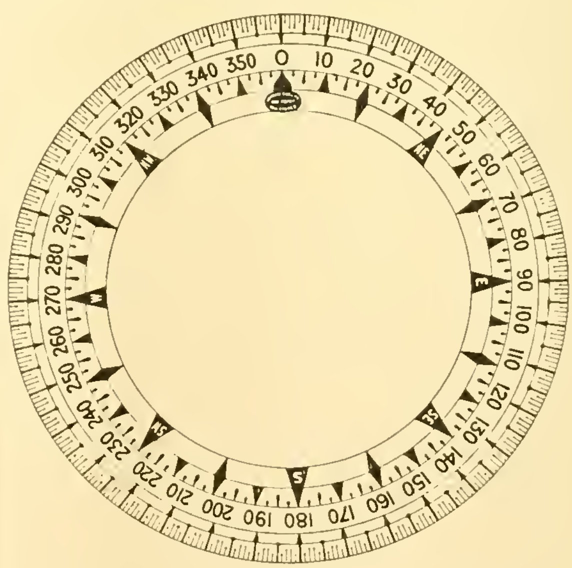



FIG. 8.—Compass with the circle of the horizon divided into 360 degrees, the N. point being 0°.

The magnetic bearings thus obtained should at once be changed into true bearings; this can be done approximately by reference to the appended maps, which bring together the recent results obtained by the Ad-

[1] Continued from p. 445.

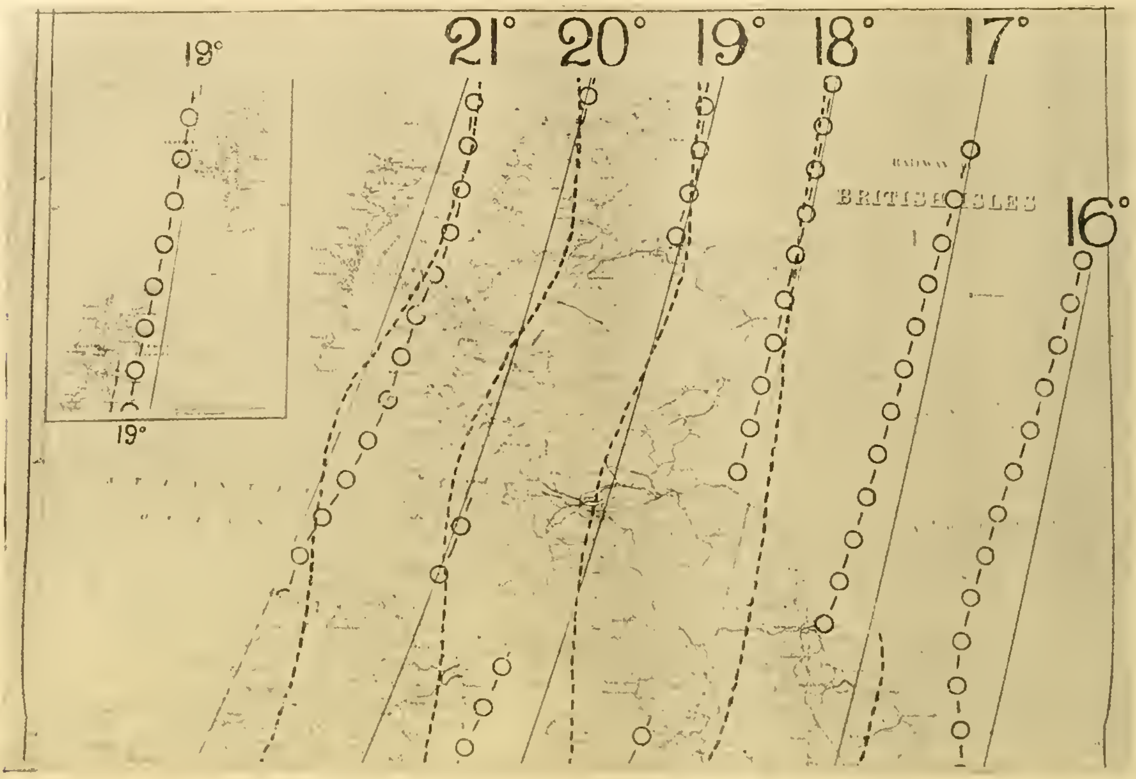



FIG. 9.—The western magnetic variation in N. Britain and N. Ireland in 1907.


FIG. 10.—The western magnetic variation in S. Britain and in S. Ireland in 1907.

miralty. The full smoothed line shows the average position of the line of equal variation for 1907, the dotted line the variation obtained from land observa-

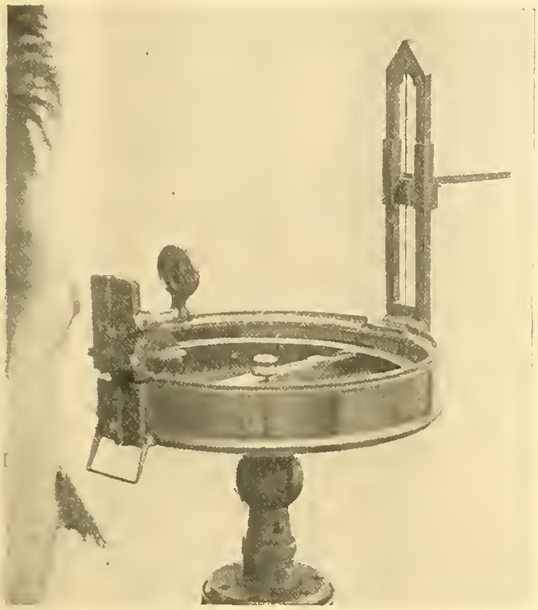


FIG. 11.—The prismatic compass, showing the sighting arrangement and manner of use.

tions alone, and the dot and circle line that got by observations at sea alone.

It will be seen that there is a strange divergence between the land and sea observations, but in spite of this the chart enables us to estimate the variation at any place on it within half a degree without astronomical observation.

I am glad to learn that the use of the mariner's compass pure and simple is now rapidly going out of use so far as archæologists are concerned, and for the rapid measurements of azimuths alone, using magnetic bearings, the azimuth, or prismatic, compass is the instrument generally employed.

It is cheap, light and handy. In the smaller instruments the needle is attached to the under surface of a compass card showing the thirty-two magnetic points. In the best forms a magnetised bar having an agate centre balanced on a steel pivot carries an aluminium or silver ring, which is graduated to half degrees, and with many monuments a greater accuracy than this is not possible. Its general arrangement will be gathered from Fig. 11. At one end of the box is a fine wire, at the other a right-angled prism; above the prism is a narrow slit, through which the wire is observed over the centre of the graduated ring. The prism reflects to the eye the graduation under the slit, so that this, the wire, and the object observed are seen together. The graduation runs from 0° to 360°, the zero lying in the N. point of the magnetic meridian, so that the graduation read is the magnetic azimuth of the object seen through the slit in line with the wire.

In order to get a zero reading under the prism when we are looking magnetic north, the zero of graduation is at the magnetic south end of the needle.

The support of the fine wire also carries a hinged mirror, by means of which the azimuths of objects considerably above the horizontal line can be measured. For measuring the azimuth of the sun on the horizon, dark glasses are attached to the slit plate, which can be thrown into use when required.

When at work, when the box is rotated to bring any object in the line of the slit and wire produced, the needle, and with it the graduated ring, remains steady.

An ordinary level, furnished with a needle and card, can also be used for taking magnetic azimuths alone.

The 25-inch maps of the Ordnance Survey have put into the hands of archæologists a tremendous engine of research, from which true azimuths can be at once found without the intervention of a magnetic instrument in the field. To do this a *circular protractor* is employed in the manner shown in the accompanying figure.

In the case of the Avenue represented, a line some 12 inches long is drawn parallel to its length. Another line is then drawn parallel to the side of the map, which is always a N. and S. line, or very nearly so. The zero of the protractor is brought on the N. and S. line, and the centre on the point of intersection. The angle between the two lines is the azimuth.

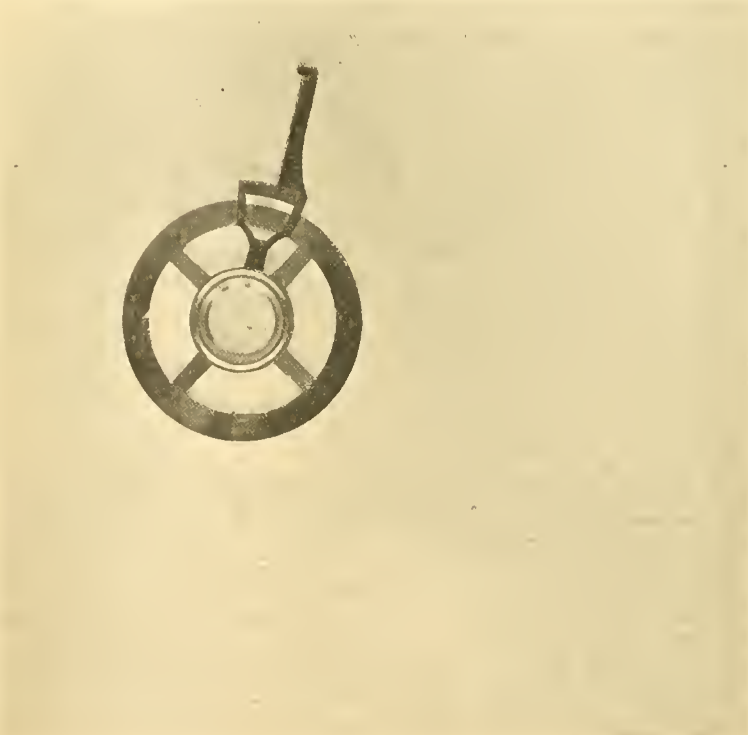


FIG. 12.—The circular protractor measuring the azimuths of an avenue on a 25-inch Ordnance Map of Dartmoor.

NORMAN LOCKYER.

## THE ROYAL COMMISSION ON WELSH MONUMENTS.

THE first meeting of the Royal Commission on Ancient Welsh Monuments in Wales and Monmouthshire, was held in London on Friday, September 11. Sir John Rhys, the Chairman of the Commission, after recounting the terms of reference, expressed his views as to the nature and scope of the Commission's work, and the lines upon which he proposed to direct its course.

"The work," he said, "would not be difficult if they proceeded from county to county and parish to parish, and simply drew up a bare list or inventory of the objects of antiquarian and historical interest therein; but it was clear that such an inventory would be of no scientific value unless those objects were classified according to their character, intention, and probable date. It was only by a comparative method that they could hope to answer many of the questions with which they would be confronted, and it was desirable, therefore, that the classificatory system adopted by the Commission should be uniform with that in use by other commissions of a similar character. With regard to ancient earthworks, he thought it would be better to adopt the divisions suggested by the Congress of Archæological Societies in 1901. No specific power was given to the Commission under which they could engage in exploratory work for the purpose of ascertaining the age or character of any particular object, though it was difficult to see how without such guidance the classification of some objects could be determined satisfactorily."

He thought the county might be taken as a proper area unit. It is proposed to publish county inventories as soon as they are finished, and thus make them available for use at once. A preliminary list of the monuments within a given county would be framed from the 6-inch Ordnance map, and supplemented by inquiries that would be made through the local secretaries and primary schools. He suggested that the sympathy and the assistance of the county councils should be sought, and that circulars should be sent to the numerous class of bards and literati, and those whom the secretaries might find interested in the work. A bibliography on the subject would be collected, and personal visits must be undertaken to the various monuments within the counties. "Those visits could be undertaken by the secretaries. It was inevitable that in the course of such work it would be found that there were monuments that, owing to the complexity of structure and other matters, must be inspected by the whole Commission, and they would have to settle points that were important and also disputed."

The points cited from the chairman's address show what a great work the Commission has undertaken. It is thought that it will take three years at least to complete its task.

Like all bodies representative of the whole Welsh nation, the Commission is very strong on the literary side, and the bibliography and all historical matter will be of the greatest value to archæologists. There is little reason to be dissatisfied with the purely scientific element in the Commission, providing that important scientific methods will not be decided upon merely by a show of hands. The chairman's remarks warrant our highest expectations as to the thoroughness with which the work will be done.

Though the Commission is not specifically empowered to engage in exploratory work, it is clear by the proposal to make personal visits to the monuments that a work more urgent and far easier than any explanatory work can and most likely will be done, namely, an astronomical survey of all monuments which lend themselves to such an inquiry. No body of experts would make such visits without an ordinary compass. All that would be required in order to make the astronomical survey of sufficient value would be a clino-compass, and sufficient acquaintance with the "run" of astronomical monuments to be able to find out alignments, to take their orientation and the height of the horizon in the same direction.

At least three members of the Commission are deeply interested in the astronomical inquiry, and the secretary, Mr. Edward Owen, has already acquainted himself with the results so far obtained in Wales. Neither expense nor time—for a monument could be surveyed in a few minutes—could be pleaded as a reason for neglecting such a golden opportunity of securing comparative data of the greatest interest. It is to be hoped that at the next meeting of the Commission this important matter will be definitely dealt with.

Now that little Wales has been so generously provided for in the matter of this Commission, the question crops up very naturally, Why has not larger England obtained the same privilege?

JOHN GRIFFITH.

## DR. SVEN HEDIN'S LATEST EXPLORATIONS.

AN interesting account of Dr. Sven Hedin's latest journey in Tibet is to be found in the *Times* of September 17 and 18, from which we gather the following particulars of the discoveries made by this intrepid explorer.

On March 8 last he came across stone houses, the residence of the local chief, but only a high lama from Lhasa was present, living in a great tent, which was a movable temple, similar to that of the Kalmucks on the Volga, indicating that religious rites are performed among the nomads.

Dr. Sven Hedin then went along the northern edge of the great tract between latitudes 30° and 32°, stretching from his old route to the Brahmaputra, which was the great object of his journey. He marched due south, crossing several ranges all running east and west. He passed the enormous ice mountain of Shakangsham on the east, from which flowed the big river. Thence he went over the Ladang pass into the open valley, and the Bongba province, which no European had ever before entered, lay open before him.

At this point great precautions had to be taken in consequence of the suspicions of the Tibetans, and the leader narrowly escaped detection whilst making barometric observations. However, the danger was averted by the march being diverted to the mountainous country where Lake Chunitso was discovered. Two more ranges were crossed, and then the open plain was reached, bounded southwards by a great mountain range, 2000 miles long, which stretches east and west.

Dr. Sven Hedin was rewarded by discovering the continuity of the chain. He found also that the course of Chartatsango, a big effluent of the Brahmaputra, had been wrongly marked on the maps.

After encountering serious opposition, and his caravan being divided, Dr. Sven Hedin left Bis on May 5, and travelling due north crossed a pass of 1900 feet in the Great Range, and made for Lake Tederam, the existence of which Nain Singh reported in 1873, its real name being Terenam. He found the lake to be long, narrow, and salt, and entirely different from its representation on the map.

He then turned westward and visited the Mending temple, situated on the bank of the Somathangpo, the largest river in Tibet, without outlet to the ocean. Crossing a range 20,000 feet high, he reached Khala, shown on the maps as a great peak, but really a pass in a high range running from the main system. He then came to Ghalaringtso, which is described in the maps as containing a monastery on an island. Its real name is Ngnanglaringtso, and there are five islands. The shape given in the maps is reported to be wrong, as it runs east and west and is intersected by three rivers. The explorer again crossed the Great Range, and reached Mansorawar on July 26, and thence by known roads made his way to Simla.

Dr. Sven Hedin sums up the results of his explorations as follows:—

"First, the true sources of the Brahmaputra and Indus, and the genetic source of the Sutlej east of Mansorawar Lake.

"Secondly, the exploration of Bongba, which I traversed twice by different routes.

"But the greatest of all is the discovery of that continuous mountain chain which, taken as a whole, is the most massive range on the crust of the earth, its average height above sea level being greater than that of the Himalayas. Its peaks are 4000 feet to 5000 feet lower than Everest, but its passes average 3000 feet higher than the Himalayan passes. The eastern and western parts were known before, but the central and highest part is in Bongba, which was previously unexplored. Not a tree or a bush covers it; there are no deep-cut valleys, as in the Himalayas, for rain is scanty. The absolute heights remain to be calculated from observations made on the ten passes which I crossed."

It is stated that the new map of Tibet will be in 900 sheets, and that all the heights of the passes, the river crossings, and the encampments are recorded; a hundred astronomical points have been fixed, and several thousand panoramas have been taken, with compass bearings and names, while many photographs, pencil drawings and water colours have been brought back, together with meteorological observations and a collection of geological specimens, with the dip and fall of the rocks, from 1200 different points. The total length of Dr. Hedin's journeys is estimated at 4000 miles.

## NOTES.

ACCORDING to Reuter's Agency, the negotiations which have been in progress for some time between Great Britain and Germany for the conclusion of the agreement to combat sleeping sickness in the African possessions of the two countries are now practically complete. It is thought that the new regulations will become operative on November 1. The convention, which is for a period of three years, provides that British and German doctors and the officials in charge of the concentration camps shall keep in touch with one another to compare the result of their various researches. Segregation camps will be established on either side of the international boundary, while infected natives will be prevented from passing into uninfected districts, such persons being detained and segregated. The convention also provides for the notification to the officials of both Governments of all infected areas, and for taking effective measures for dealing with crocodiles or other animals which may be found to be the food of the fly which carries the disease.

THE death is announced, at the age of eighty-nine years, of Prof. J. G. Hjalmar Kinberg, of Stockholm, well known as a medical practitioner and as a zoologist; also (at the age of sixty-two years) of Prince Ivan R. Tarkanoff, until 1895 professor of physiology in the Military Academy of St. Petersburg, and since that date *privat-docent* on biology and physiology.

THE death is announced, at the age of sixty-one years, of Mr. George Nicholson, formerly curator of the Royal Gardens, Kew.

A COMMITTEE has been formed, under the chairmanship of ex-President Loubet, for the purpose of erecting a monument to the memory of the late Prof. Cornil at his birthplace, Cusset, near Vichy, France, and a public subscription list for the object in view has been opened.

SOME time ago a subcommittee of the Royal Society of Victoria was appointed to consider the question of establishing a memorial of the late Dr. A. W. Howitt. We learn from the *Victorian Naturalist* that it has now been decided to raise a fund of at least 100*l.* to found a "Howitt" medal, to be awarded from time to time to the author of distinguished work dealing specially with the natural science of Australia.

WE have to record with regret that a serious accident, attended with a fatal result, happened to the aëroplane of Mr. Orville Wright on September 17. The machine, after successfully making several evolutions, suddenly fell to the ground, in consequence, it is stated, of the breaking off of a blade of one of the propellers, and thus disturbing the balance. Mr. Wright sustained a fractured leg, and Lieut. Selfridge, who accompanied him as a passenger, has died from the effects of his injuries.

MR. WILBUR WRIGHT made a successful flight in his aëroplane at Le Mans on Monday last. The flight lasted 1h. 31m. 25s., in which time he covered 66 kilometres 600 metres, thus surpassing all previous performances both as to distance and time.

DR. SVEN HEDIN has accepted the invitation to lecture before the German Geographical Society at Berlin on the results of his recent explorations.

ACCORDING to the Stockholm correspondent of the *Globe*, the expedition under Prof. Baron Gerard de Geer, of the Stockholm University, which has been exploring the Spitsbergen group of islands, has just returned. The results (in geography, geology, biology, and hydrography) are reported to be most interesting. They will be submitted to the International Congress of Geology which is to be held at Stockholm in 1910.

ACCORDING to the *Times* of Monday last, the Royal Geographical Society has received information (dated from Khotan, July 15) from Dr. M. A. Stein respecting that explorer's latest archæological and geographical investigations in Central Asia. March and the early part of April were spent in archæological labours along the desert belt adjoining the oasis from Domoko to Khotan. Amongst the ruins newly traced there are the remains of a large Buddhist temple, decorated with elaborate frescoes, now completely buried by high dunes in the desert strip between the Yurung-kash and the Kara-kash rivers. On the curious desert hill of Mazar-tagh, which flanks the Khotan river on the west, some six marches below the Khotan oasis, Dr. Stein discovered the ruins of a fortified watch station once guarding the river route, and from great masses of refuse recovered numerous documents on wood and paper, in a variety of scripts, mainly Indian, Chinese, and Tibetan, and none apparently later than the eighth and ninth centuries A.D., many of which are stated closely to correspond in appearance and character with the records brought to light by Dr. Stein last year from the ruined fort of Miran, south of Lop-nor. By the beginning of May the expedition reached Aksu, where Dr. Stein was able to arrange for the local help which Rai Lal Singh needed for the continuous survey he was to carry along the outer Tian-shan range westwards as far as the passes above Kashgar. Dr. Stein himself travelled up the Uch-Turfan valley, and thence marched by a route not shown by published maps across a barren but remarkably picturesque mountain range to the oasis of Kelpin. A rapid journey *via* Yarkand brought Dr. Stein by the middle of June back to Khotan, where he expected to remain until the end of July engaged in packing and arranging the archæological collections gathered in his two years' wanderings. After completing his task at Khotan, Dr. Stein hoped to carry out, with Rai Lal Singh, explorations in those parts of the high Kwenlun range about the Yurung-kash and Kara-kash sources which still remain to be surveyed, and late in September to be able to start on the return journey to India over the passes of the Kara-korum, and to arrive in England in December.

THE nomination for the directorship of the new Australian Institute of Tropical Medicine has been delegated to the Royal Society and the Schools of Tropical Medicine of Liverpool and London, which institutions, according to the *Times*, have formally accepted the delegation. After nomination, however, the actual appointment of the director will be made by Prof. Martin, F.R.S., of the Lister Institute of Preventive Medicine, acting in conjunction with the Bishop of North Queensland, on behalf of the Australian universities having medical schools and of the Governments concerned. The institute, assisted by a grant of 400*l.* from the Colonial Office, is being subsidised by annual grants from the Commonwealth and the Queensland Governments. It will be established at Townsville, North Queensland.

MR. ROBERT NELSON has been appointed by the Home Secretary to the newly created post of his Majesty's Electrical Inspector of Mines; he has also been directed to act as an inspector for the purposes of the Metalliferous Mines Regulation Acts, 1872 and 1875, and of the Quarries Act, 1894. Mr. Nelson has further been appointed an inspector of factories and workshops for the purposes of the Factory and Workshop Act, 1901.

DR. LEWIS GOUGH, of the Transvaal Museum, has been appointed zoologist to the Government veterinary bacteriologist, Pretoria.

THE first general meeting of the recently formed Institute of Metals is to take place at Birmingham on November 11. The gathering will probably occupy two days. Mr. G. Shaw Scott has just been appointed secretary of the institute.

AN all Russian Oto-Laryngological Congress (the first of its kind) is to be held at the Pirogoff Museum on January 8–11 next, and in connection with it there will be an exhibition of instruments, apparatus, &c.

THE trustees of the Samuel D. Gross prize of the Philadelphia Academy of Surgery give notice that they are prepared to receive essays in competition for the prize until January 1, 1910. The prize, value 1500 dollars, is awarded every five years to the writer (such being an American citizen) of the best original essay, not exceeding 150 printed octavo pages, illustrative of some subject in surgical pathology or surgical practice, founded upon original investigations.

MR. J. B. TYRRELL, of Toronto, offers a prize of 100 dollars for the best collection of minerals collected during the year 1908 in the province of Ontario by anyone not a professional collector. The collection must contain not less than thirty specimens, each bearing a label giving particulars as to the exact locality from which it was obtained and the date on which it was collected. Competing collections must be addressed "Tyrrell Prize, Government Assay Office, Belleville, Ont.," and reach the address in question by December 1 next.

AN appliance for working the keyboard of a typewriter on a type-setting machine from a distance by means of wireless telegraphy has been devised by Mr. Hans Knudsen, and a demonstration of the experimental apparatus was given at the Hotel Cecil on Thursday last.

THE skeleton of the mammoth which was found in January last in the sandy bed of the river Sangar-Yurach has now been conveyed under the auspices of the Imperial Academy of Science to St. Petersburg. The specimen is to be mounted in the zoological museum at St. Petersburg.

ALTHOUGH the capture of giant "devil-fish," or eagle-rays, in tropical waters is by no means an uncommon event, it is but seldom that accurate measurements and photographs of specimens of this nature are obtained. We have therefore reproduced the photograph of one of

Giant "Devil-fish" taken at High Island, Texas.

these fishes (for which we are indebted to the Rev. T. R. R. Stebbing) recently landed at High Island, off the coast of Texas, together with certain particulars regarding its size as recorded in the *Daily Picayune*, New Orleans, of August 2. The fish, as shown by the form of its "horns," is a species of Ceratoptera; it measured 12½ feet in transverse diameter, and 9 feet from the mouth to the root of the tail. The interval between the eyes was 44 inches, and the diameter of the mouth 36 inches. No means of ascertaining the weight of the monster were available, although, at a low estimate, this was surmised to be at least 1300 lb. When first seen, the fish was thought to be a couple of porpoises swimming side by side; it was killed by repeated rifle-shots, by the first of which it was struck in the head near one of the eyes. According to local observers, the pair of processes which project like horns from the sides of the head are used to make a disturbance in the water and drive small fishes into the creature's capacious mouth.

To the July number of the *Emu* Mr. H. C. Oberholser contributes a useful synopsis of the known species of swans, recent and fossil. Living swans the author divides into the genera Cygnus, Olor, and Chenopis, the South American Coscoroba being regarded (we think wrongly) as a duck. In our opinion such generic divisions seem superfluous, but if they are adopted surely the emendation Chenopsis for the absurd and meaningless Chenopis might be accepted. The large Pleistocene swan of Malta is referred to yet another genus, under the name of *Palaeocygnus falconeri*, on account of its relatively short thigh-bone, long metatarsus, and short, thick toe-bones. A fossil black swan (*Chenopsis sumnerensis*) has been named on the evidence of bones from a cave at Sumner, near Christchurch, New Zealand, and a second (*Ch. nanus*), of very small size, from Pleistocene or Pliocene deposits at Lake Eyre, South Australia. From the same locality have been obtained remains of a larger swan which Mr. de Vis has made the type of yet another genus, under the name of *Archaeocygnus lacustris*, despite the apparent slightness of the osteological differences by which it is distinguished from the existing black swan.

IN sending a copy of part iii. of the first volume of the Annals of the Natal Government Museum, Dr. Warren refers to the large number of plates necessary for the proper illustration of the specimens described, which comprise a large number of new species. As these plates, of which there are no less than fourteen (with five of double size) in the present issue, are executed, for the most part in London, in the best possible style, the expenses of publication are necessarily very great. An increase in the number of subscribers is therefore asked for, in order that this invaluable journal may be carried on in the same style as hitherto. The contents of the present part comprise an article by the editor on a collection of hydroid zoophytes, for the most part from the Natal coast, in which several new species are described, while others receive fuller illustration and description than have previously been accorded them. Mr. G. A. Boulenger describes several new fresh-water fishes and reptiles (including one of Zonurus and another of Gerrhosaurus), while in a third paper Mr. C. T. Regan contributes to our knowledge of the marine fish-fauna of this part of Africa.

THE greater portion of the third part of vol. xxxviii. of *Gegenbaurs Morphologisches Jahrbuch* is devoted to an article on the human sacrum, by Dr. C. Radlauer, of the Anthropological Institute of Zurich University. After the examination of a very large series of specimens, the author finds that, in addition to a remarkably large range of individual variation, this portion of the skeleton also shows modifications dependent upon sex and race, special attention being devoted to variations of the latter type. As regards individualism, it is pointed out that whereas five vertebræ normally unite to form the sacrum, the number may be occasionally reduced to four or augmented to six, the addition being less uncommon than the subtraction of an element. As regards sexual variation, the sacrum is relatively broader in the female than in the male. The breadth in both sexes (each for each) is, however, greater in European than in non-European races; there is also a distinction in the form of the under surface in European sacra compared with those of other races. Bushmen, Malays, and Chinese possess a sacrum of the "dolichohierische" type; in most negroes, Ainus, and Japanese the type is "subplatyhierische," while in some Japanese, Australians, and Europeans it becomes "platyhierische." In view of recent changes of view in regard to the relationship of the natives of Australia, their association from the present standpoint with Europeans is extremely significant.

GRAPHIC methods of recording and utilising bird-migration data form the subject of an article by Mr. W. Stone in the April issue of the Proceedings of the Philadelphia Academy of Sciences. The date of the first arrival of one particular species in a given locality is not a fact of much importance or value, and the author suggests, in lieu of the recording of such isolated cases, maps for certain districts embracing a ten-mile radius should be prepared on which all early arrivals can be plotted. Charts showing temperature-variation in connection with bird-migration are also suggested and exemplified by samples.

IN *Annotationes Zoologicae Japonenses*, vol. vi., part iv., Mr. I. Ikeda records the interesting fact that at certain seasons the relative of Balanoglossus known as *Glandiceps hacksii* consorts in swarms and assumes a pelagic habit. In the same issue Dr. A. Oka describes a new genus and species (*Stephanella hina*) of fresh-water bryozoans from Japan. In many respects the new genus differs from any hitherto known, this being specially noticeable as regards the peculiar conformation of the colony, which differs from that of all other phylactolæmatous fresh-water bryozoans in that it consists of a thick, creeping stolon and of a single upright polyp-stem, such as is found in certain marine members of the ctenostomatous group.

A SECOND botanical part of the *Philippine Journal of Science*, issued in June, contains a paper by Signor M. Ugolino on the native species of Pandanus, describing varieties of *Pandanus tectorius* and several new species. Among the determinations of Philippine fungi communicated by Dr. P. Hennings are new species of Uredo, Aecidium, Phyllachora, Rosellinia, and Diplodia. One species of Rosellinia and *Pestalozzia palmarum*, genera known as insidious pests in the tropics, were taken on cocoa-nut trees, and a Diplodia was obtained from the scales of a Pandanus fruit. Mr. E. D. Merrill contributes an article on the plants collected by the Wilkes United States Expedition in 1842, and a further instalment of botanical literature connected with the islands.

MR. A. M. F. CACCIA has compiled a glossary of technical terms for use in Indian forestry that has been published as Forest Pamphlet No. 3 by the Government of India. The forester's vocabulary consists of many technical expressions such as form factors, sylvicultural systems, classes of rotation, as well as terms that have a special application, to wit, fireline and forest devil. The Indian forester cannot be accused of coining terms, as "taungya" or "jhum" and "indaing" appear to be the only contributions, the former referring to sowing the seed of special trees with field crops, the latter to forests where "in" trees, species of Dipterocarpus, abound. A special list of American terms furnishes a tribute to the push of American foresters. Tree scribe, volunteer growth, and veteran require explanation, but to harden off and sapling sound distinctly British.

AN account of the plant formations in mid and southern Greece, contributed by Dr. E. Pritzel to Engler's *Botanische Jahrbücher* (vol. xli., part iii.), derives special interest from the classic associations connected with the regions described. Olive trees still clothe thickly the Attic plain, and the vine foliage colours the valley of the Cephissos that flows towards the Piræus. In other parts the evergreen formations termed "maquis" are found. The characteristic trees in the maquis are the Aleppo pine, species of Arbutus, and *Quercus coccifera*. A subformation, the "phrygana," consists of bushes and other xerophytes. Here grows the Greek thyme, *Thymus capitatus*, famous as the food of the bees of Hymettus; associated with it are *Poterium spinosum*, *Genista acanthoclada*, and *Phlomis fruticosa*.

In the September issue of *Man* Prof. J. G. Frazer discusses three remarkable statues of kings of Dahome now deposited in the Trocadero Museum. The figures are symbolical, each king being represented in the guise of an animal. Thus, Guezo, who reigned from 1818–58, and was known as "the cock," is represented by a man covered with feathers; Guelele (1858–89), "the lion," as a lion rampant; Behanzin, his successor, who was finally deposed by the French, known as "the shark," appears as a dogfish graced with the arms and supported by human legs. The "feathers" which once covered the statue of Guezo are nothing but metal plates, nails, gimlets, and scraps of old iron. Prof. Frazer observes that the existence of these statues seems to prove that certain kings of Dahome habitually posed as certain fierce animals or as birds. They possibly intended by this means to serve some magical purpose. At any rate, they cannot be totems hereditary in the male line, since they differed in three successive generations traced from father to son.

Mr. A. L. Kroeber, in the second Bulletin of the eighth volume of the reports on American archæology and ethnology issued by the University of California, publishes an elaborate memoir on the Cahuilla Indian tribe which occupies the southern part of the province. The primitive culture of this people has in a great measure disappeared, but Mr. Kroeber has been able to collect a number of interesting exhibits which throw light upon their social and religious culture. This is not of a uniform type, being largely conditioned by the varied environment to which they are exposed. Basketry in the form of domestic appliances, mortars, caps, granaries, water jugs, and the like, is, as is usual among the neighbouring tribes, ingenious and artistic. The few examples of pottery discovered, though of an inferior class, are interesting as specimens of an art which has now practically disappeared; in fact, so little has been found that it was at one time supposed that the art of manufacture was unknown to these Indian tribes. Bows and arrows, flutes, and digging-sticks are some of their manufactures in wood. Most of the ceremonial objects connected with their pagan rites have disappeared since their adoption of Christianity, and the same is the case with their ceremonies, the most important of which were an annual tribal mourning for the dead, a puberty rite for girls, and an initiation ritual for youths, at which the jimson-weed was infused and drunk as a mode of producing religious ecstasy. The numerous illustrations appended to the report clearly illustrate the culture of this rapidly disappearing people.

The Mitchelstown caves, described by Dr. C. A. Hill in a paper before the Geographical Section of the recent British Association meeting, have since been completely explored and surveyed. These caves are of great interest, not only from the fact that they are the largest in the British Isles, but also on account of their historical associations. The earliest plan is that of Dr. Apjohn, in 1833, and a later one was published by M. Martel in 1893. Many new passages have now been discovered, and it is hoped that the new plan, together with a description, will be published shortly. The work of survey and exploration was carried out by Mr. H. Brodrick, Drs. C. A. Hill and A. Rule, of Liverpool, and Mr. R. Lloyd Praeger, of Dublin.

The current issue of the Transactions of the Geological Society of South Africa, covering the period from January to June, affords evidence of the admirable work that is being done in the scientific investigation of South African mineral deposits. Mr. H. Merensky describes the rocks belonging to the area of the Bushveld granite complex, in which tin may be expected. The descriptions of the deposits actually found show that the local conditions correspond in all essential points with those in other parts of the world. Mr. E. P. Mennell describes the occurrence of diamonds at Somabula and Bembezi, in Rhodesia. Mr. R. B. Young records the occurrence of yellow and red ochre in the Potchefstroom district, Transvaal. The occurrence is of interest commercially, and also on account of the clear indications that it is the result of the extreme decomposition of an igneous rock. Mr. A. L. Hall and Mr. W. A. Humphrey describe the occurrence of chromite deposits along the southern and eastern margins of the Bushveld plutonic complex. The ore occurs in veins in norites, hypersthenites, enstatite rocks, and olivine-bearing serpentines. The occurrence of platinum in some of the chromite deposits is of great interest in view of the close general resemblance to the conditions under which platinum is found *in situ* in the Ural, and suggests the possibility of finding alluvial platinum in South Africa. This number of the Transactions also contains important papers on contact metamorphism in the Pretoria series of the Lydenburg and Zoutpansberg district by Mr. A. L. Hall, on contemporaneous igneous rocks in the Pretoria series by Mr. A. L. Hall, and on the stratigraphy of Zwartkop by Mr. G. S. Corstorphine and Mr. E. Jorissen.

From the Department of the Interior, Manila, we have received an attractive pamphlet of thirty-nine quarto pages, with six plates and two maps, issued by Mr. Warren D. Smith, chief of the division of geology and mines. It deals with the mineral resources of the Philippine Islands, and contains the first annual statement of mineral production. The production in 1907 consisted of 4540 ounces of gold, 83 ounces of silver, 436 tons of iron, and 4545 tons of coal. Although the figures are insignificant, the record is a valuable one as indicating the progress that has been made in placing the mining industry on a satisfactory basis. Many difficulties are encountered. Natural features of the country are sometimes insurmountable, and the labour question is a serious one. The history of the district of Benguet shows, however, that a sure and profitable mining industry can be built up in the islands. Appended to the report are memoirs on the geology of north-western Mindanao, on mining prospects on the Zamboanga peninsula, on the characteristics of Philippine ores, and on the characteristics of Philippine coals. Most of the coals are useful for steaming purposes, and for the production of power the utilisation of the outcrop coal for producer-gas seems extremely promising.

In view of the centenary of James Nasmyth's birth, the date of which was August 19, 1808, a review of his engineering work is published in the *Engineer* of September 18. Nasmyth invented the steam hammer in 1839, and applied the steam hammer to pile-driving in 1845. The details given of numerous other new ideas he presented to the world clearly show to what a large extent engineers are indebted to him.

The new edition of the French pharmacopœia (the "Codex Medicamentarius"), which has been recently issued, differs materially from the edition immediately preceding it, which appeared in 1884. The alterations are chiefly concerned with the simplification of preparations, such as the tinctures of iron and opium, in the manner recommended by the recent International Convention which considered the maximum doses of potent drugs. Many preparations which have fallen into disuse, and which had become stereotyped in former editions, have been omitted from the one just published, while a certain number of new drugs are included, such as adrenalin, theobromine, tuberculin, and other agents employed in opsonic, vaccine, and serum therapy.

THE Journal of the Royal Sanitary Institute for September (xxix., No. 8) contains papers read at the congress at Bristol. Dr. Savage deals with the hygienic preparation of sausages, showing that, as ordinarily prepared, they always contain *Bacillus coli* in numbers varying from 10 to 120,000 per gram. The presence of this organism in such large numbers is evidence of an undesirable want of cleanliness in some part of the process of manufacture.

THE *Rendiconti* of the Reale Accademia dei Lincei, part ii., 1908, contain an account, by Dr. C. Alessandri, of observations of solar radiation at the Regina Margherita Observatory on Monte Rosa (lat. 45° 56′) in the months of August and September, 1905 and 1906. This study of solar radiation at an altitude of 4560 metres is an important contribution towards the solution of the intricate question of the possible influence of the sun's varying intensity on the weather at the earth's surface. The observations were made with Angström's pyrheliometer, to which are added the readings of Arago's actinometer, air pressure, temperature, and other data. At the time of the solar eclipse of August 30, 1905, which occurred at Monte Rosa between 1h. 5m. and 2h. 55m. p.m., with a perfectly clear sky, the values obtained vary from 1·651 gram calories at 12h. 41m. to 0·298 at 2h. 20m. and 1·530 at 3h. 39m. p.m. The observations made in 1907 will be communicated to the academy in a subsequent note.

## OUR ASTRONOMICAL COLUMN.

COMET MOREHOUSE, 1908*c*.—Although, according to its ephemeris, Morehouse's comet is increasing in brightness, it still remains a disappointing object except to those possessing large instruments; this is probably due partly to its diffuse nebulous nature and partly to the strong moonlight that has obtained during the time which has elapsed since its discovery on September 1.

Numerous observations of this object are recorded in No. 4273 of the *Astronomische Nachrichten* (p. 14, September 14), having been communicated, telegraphically, to the Kiel Centralstelle. The comet's magnitude was recorded as 9·0 at Copenhagen and at Uccle on September 4, as 10·0 by Prof. Palisa at Vienna on September 5, and as 9·3 and 9·0 at Strassburg on September 5 and 7 respectively. In the latter observation, Prof. Wirtz records the appearance of a small, fine tail in position-angle 230°. An indefinite condensation, 2′ in diameter and about as bright as a ninth-magnitude star, was observed by Prof. Abetti, at Arcetri, on September 4, the condensation appearing more especially in the north-east section of the nebulous patch. An observation by M. Sternberg at Moscow on September 6 revealed no nucleus.

A telegram from Paris, received at Kiel at midday on September 4, announced that the comet was discovered independently by M. Borrelly at 10h. 0m. (Marseilles M.T.) on September 3; its magnitude was given as 10·0, its movement as north-east, and it was said to possess a feeble condensation and a small tail. Prof. Morehouse described the tail as "long and conspicuous," and the apparent discrepancy is, possibly, due to the fact that he discovered the comet photographically. Observed visually, the tail is not conspicuous, but photographs taken with the 36-inch reflector of the Solar Physics Observatory show that there is a fairly prominent tail with at least two main streamers.

Owing to the diffuseness and faintness of the comet, no observations of its spectrum have, as yet, been possible.

According to the ephemeris given in these columns last week, the comet should be some $4\frac{1}{2}$m. W. and 2° 17′ N. of the 3·3 magnitude star $\beta$ Cephei at 10 p.m. (G.M.T.) on September 30, and its brightness should then be about $3\frac{1}{2}$ times that at the time of discovery.

THE ORBITS OF SEVERAL SPECTROSCOPIC BINARIES.—Lick Observatory Bulletin No. 133 contains several notes referring to different stars which the observations have shown to be spectroscopic binaries.

First, Mr. Plummer discusses the orbit of $o$ Leonis, the spectrum of which has been differently classified by different observers, and some difficulty found in bringing the velocity measures into accordance. It is now found that the spectra of both components appear when the latter are separated by the greatest distance.

The masses of the two components are almost equal, and the period is found to be 14·4980 days, the orbit being very nearly circular.

The period of $\beta$ Herculis is found to be 410·575 days; the eccentricity of its orbit is 0·5498, and the length of the semi-major axis 60,280,000 km.

The perturbation discovered in the orbital motion of the visual binary $\xi$ Ursæ Majoris by Mr. N. E. Nörlund is found by Mr. W. H. Wright to be due to the fact that the principal component itself is a spectroscopic binary, the measures already made indicating that Mr. Nörlund's period of 1·8 years is not far wrong.

In the last note Mr. A. B. Turner compares the elements of the orbit of $\omega$ Draconis as derived by the analytical method with those obtained by the method of Lehman-Filhés, and the final elements from a least-square solution. The period is found to be 5·2796 days, the eccentricity 0·016, and the semi-major axis 2,626,700 km.

THE DETERMINATION OF TIME IN SUBTROPICAL LATITUDES.—A paper by Messrs. Wade and Craig, appearing in No. 21, vol. ii., of the *Cairo Scientific Journal*, describes a method which was devised by the authors, and has been found very useful, for determining local time, with great precision, in subtropical latitudes. The method differs from those proposed by Chandler and Cooke, inasmuch as the observations are not restricted to a circle passing through the pole, and is therefore more suitable for equatorial latitudes. The method of observation consists in taking transits of a pair of stars, one east and one west, at the altitude of their maximum elongation when the star is rising vertically, stars being chosen so that the maximum elongation takes place as near as possible to the prime vertical. It is shown by the authors that the computation of results becomes a simpler matter, and that many corrections which have to be applied in other methods are either eliminated or negligible.

CAMBRIDGE UNIVERSITY OBSERVATORY.—From the annual report of the observatory syndicate we learn that the work of Cambridge University Observatory during the period 1907 May 19 to 1908 May 18 was directed along the usual lines. Stellar parallax work was continued with the Sheepshanks equatorial, and was somewhat retarded by poor weather at the beginning of this year. Valuable catalogues of star-places are evolving from the Eros solar-parallax reductions, and it is hoped that the first solution of the whole material will be made during the present year.

Stellar spectroscopy, solar observations, and the laboratory study of spectra formed the programme for the Newall telescope, and an attempt is being made to develop a method for utilising the sharply defined atmospheric lines of the $\alpha$ and B groups as standard lines in the determination of radial velocities of stars. At present the method is not successful with faint stars owing to the lack of sensitiveness of the photographic plates and to the want of brilliancy of the diffraction gratings available for use in the spectroscope employed.

## THE ROYAL PHOTOGRAPHIC SOCIETY'S ANNUAL EXHIBITION.

THIS exhibition, which will remain open for a few weeks, is, as usual, at the New Gallery, Regent Street. It is divided into several sections, namely:—(1) pictorial; (2) scientific and technical; (3) lantern-slides; (4) autochromes; (5) portraits of eminent British subjects from the society's collection; (6) general professional work; (7) trade exhibits of apparatus and materials. We notice a welcome though slight tendency in the pictorial section to return to the old custom of stating by what process the print has been produced, information that is not only due to any prospective purchaser, but also gives the exhibit an interest for the technical student, while it in no sense detracts from its pictorial value.

There are no new methods of photography in colours. The coloured prints in the pictorial section are, so far as we notice, coloured by hand. The chief interest of the autochromes lies in the application of these plates to the photography of other subjects than portraits, views, and still-life groups. Dr. H. G. D. Brockman demonstrates, in a series of thirteen, their usefulness in recording the presence of blood-stains in a room, on various articles of clothing, and on a bottle, in connection with a trial for murder. In some cases the article was "subjected to a stream of oxygen in an atmosphere which was supersaturated with water vapour and at a temperature of 70° F. As a consequence, certain tarry-looking stains on the boots which were thought to be blood became ruddy." The effect of this treatment is shown by comparative photographs. The same exhibitor has eight autochromes of pathological subjects, which will convey a very good idea of what may be expected when these plates are used for such work. Mr. C. P. Butler shows a direct photograph of the solar spectrum taken on "Uto" paper, in which the colours of the spectrum are excellently rendered.

The natural history division includes a few autochromes which show the great advantage of colour photographs of such subjects, in spite of the fact that the tints depend to a certain extent upon the manipulation of the plates. In a very considerable collection of monochrome photographs, "The Stoat," by Mr. Douglas English, appears, we believe, for the first time. There are several series of pictures of great interest. Mr. William Farren, for example, gives fourteen photographs of the nest of a song thrush, which illustrate the rapid growth of the young birds and the feeding of them by the parents, and he appends a short history of the events, with dates and many details, from the hatching to the time the nestlings left the nest. Similar series are contributed by Mr. Alfred Taylor, which illustrate the "domestic habits of the song thrush" and "the life-history of the tawny owl." A series of eight radiographs, by Messrs. Wilson and Blackall, show the gradual development of the bones of the hand from three to eighteen years of age. Among the photomicrographs, some examples of low-power work, of five and ten diameters, by Mr. W. F. Cooper, are specially noteworthy.

The progress made in cutting the Panama Canal is clearly shown in ten photographs by Dr. Vaughan Cornish, with a map and vertical section. Mr. J. Howden Wilkie has succeeded in two cases in photographing the same flash of lightning with both a stationary and a moving camera. Captain Owen Wheeler, who has made a speciality of telephotography, demonstrates in a remarkable way that it is possible to produce telephotographs of seven and nine diameters' magnification of such good definition that they will well stand a further enlargement of four diameters. The detection of forgery by photographic means is well illustrated by Dr. R. A. Reiss.

Astronomical work is not largely represented, the only exhibits we noticed being the spectrum of "Mars" in the region of "a" compared with spectra of the moon, by Mr. V. M. Slipher, which shows the presence of water vapour in the atmosphere of the planet, and some lantern-slides of the sun and sun-spots made by Mr. C. W. Barlow using an old $4\frac{1}{4}$-inch refractor, with a deep yellow screen interposed.

C. J.

## THE BRITISH ASSOCIATION.

### SECTION G.

#### ENGINEERING.

OPENING ADDRESS BY DUGALD CLERK, F.R.S., M.INST.C.E., F.C.S., PRESIDENT OF THE SECTION.

AT the middle of the last century the steam engine had attained to a high degree of perfection. Its development was, it is true, incomplete, but it had been successfully applied to all the great duties of the mine, the waterworks, the factory, the railway, and the steamship. The engines were mechanically excellent; the fuel economy was good, and they were built in units of thousands of horse-power. Steam power, in fact, was revolutionising the whole of the social and industrial conditions of the globe. Notwithstanding this great material and engineering success, the world was in complete darkness as to the connection between steam motive-power and heat. It was seen that motive-power of almost any magnitude could be obtained by the agency of heat; but how it was obtained and how much power was connected with a given quantity of heat was quite unknown. The fuel consumptions of existing engines were known, and certain modes of improving economy were evident, and engineers were busily engaged in testing these modes by the slow but sure methods of invention, design, construction, and operation in practical work; but in this they had but little aid from pure science.

The science of thermodynamics did not yet exist.

New light was dawning, however, which gradually illumined the whole world of pure science and engineering practice.

Men of the first rank in intellect—Newton, Cavendish, Rumford, Young, and Davy—had long before expressed the opinion that heat was not material in its nature, but was a mode of motion; but their opinions, although to some extent supported by experiment, made little impression upon the scientific world, and in 1850 we still find the most distinguished physicists adhering to the "caloric" or material theory of heat.

The great change, from the errors of the old theories to the truth of the new, was due to the work of Joule, Thomson, and Rankine in Great Britain, and of Carnot, Meyer, Clausius, Helmholtz, and Hirn on the Continent. The story begins with the work of Carnot in 1824, who published in Paris in that year a pamphlet entitled "Reflections upon the Motive Power of Heat." He was attracted by the problem of the steam engine and the air engine. He saw that heat and motive power were connected in some manner, and he endeavoured to settle in a quantitative way the limits of that connection by the invention of an ideal series of operations by means of which the greatest conceivable amount of mechanical power may be obtained from a given quantity of heat in given circumstances. For the purpose of his demonstration he assumes only two things: (1) That if heat be added to any body under standard conditions of temperature, pressure, and volume, and the body be carried through any series of mechanical processes, returning ultimately to the standard condition of temperature, pressure, and volume, then the quantity of heat added to the body is the same as that which has been discharged from it; (2) no process can exist whereby a given mechanical energy can increase its own quantity. On these indisputable assumptions he bases his ideal cycle, which consists of four simple and easily imagined operations, occurring within a cylinder behind a piston, so arranged that during the cycle work can be done by the working fluid upon the piston or work done by the piston on the working fluid.

*First Operation.*—The given volume of the working fluid is to be imagined as confined at its highest temperature and pressure behind the piston, and heat is to be added to keep the temperature constant, while the fluid expands, moving the piston and doing work upon it.

*Second Operation.*—The supply of heat is cut off, and the working fluid expands also during work on the piston, while its temperature falls to the lowest point and its volume increases to its maximum.

*Third Operation.*—The piston returns, compressing the working fluid, but allowing the heat of compression to escape, so that the temperature remains during the operation at its lowest point.

*Fourth Operation.*—The piston compresses the working fluid, without allowing any loss of heat, to such an extent that the temperature rises again to its highest point, and the working fluid exists at the end of this operation at the same volume, pressure, and temperature as at the beginning.

This assumed series of operations would give a certain available work area, the indicated power of the engine, inasmuch as the work done by the working fluid would be greater than that done upon it. If, however, it be assumed that in all the operations the direction of motion of the piston be reversed, then compression without loss of heat would take place in the second operation; further compression, but with sufficient heat loss to keep temperature constant, would occur on the first operation; the fourth operation would follow with expansion, and the third operation would conclude also with expansion. The engine would be reversed by beginning with the second operation, moving the piston backwards in the order second, first, fourth, third. Carnot shows that this reverse operation would be performed by exactly the same amount of work as was given out by the direct operation, and that an amount of heat would be returned at the higher temperature equal to that which was added in the first case.

An engine which fulfils these conditions, Carnot states, will give the greatest amount of work which can be obtained from a given quantity of heat falling through a given temperature range. And it is evident that this must be so, because, if we assume the existence of any engine under the same conditions giving a greater amount of work from the same heat, then that engine could drive a Carnot engine in the reverse direction in such proportion as to return to the higher temperature a greater amount of heat than it abstracted, and so mechanical energy could be obtained without any heat fall whatever. This marvellous demonstration is obviously independent of the nature of the working fluid; it applies equally to all working substances, whether solid, liquid, or gaseous, whether physical state changes or not. It at once gives a standard of the limit of mechanical power which could possibly be obtained from a given amount of heat and a given temperature fall.

The Carnot cycle operations, as here given, are applicable either to the material or to the dynamical theory of heat; but Carnot originally stated that the whole of the heat added in the first operation was to be discharged in the third. Under the material or caloric theory, work was supposed to be done by the fact of fall in temperature. Naturally, as the heat was material it could not be destroyed or changed into mechanical energy. The production of mechanical energy was supposed to be incidental to the fall of temperature, much in the same way as mechanical energy was produced by the fall of water-level, and this analogy is used throughout Carnot's work of 1824.

Carnot thus succeeded in proposing a standard of efficiency which was applicable to any heat engine, whatever the working fluid and whatever the operative cycle. By his method a limit could be set, fixing the maximum of mechanical energy to be obtained from a given heat quantity and a given temperature range. To reduce this to numerical values it was necessary, however, to experiment on any one working fluid within the desired temperature range in order to determine the work area in its relation to heat quantity and temperature fall. Carnot's writings show that he intended to make such observations; and, had he succeeded, thermodynamics would have become a science at an early date. Carnot's death, however, in 1832, at the sadly early age of thirty-six years, prevented this development.

The name of Sadi Carnot will always be remembered by mankind as the founder of one branch of the thermodynamics of the heat engine.

His work remained practically without notice for thirteen years after his death, when, fortunately, it attracted the attention of William Thomson during his attendance at the Laboratory of Regnault in the year 1845. Thomson was then twenty-one years of age, and had already attained a considerable scientific reputation. He took up the study of Carnot's work with enthusiasm. He became Professor of Natural Philosophy in the University of Glasgow in 1846, and in 1848 he read a Paper before the Cambridge Philosophical Society "On an Absolute Thermometric Scale founded on Carnot's Theory of the Motive Power of Heat and calculated from Regnault's Observations." Like Carnot, Thomson accepted the "material" or "caloric" theory of the nature of heat, although, like Carnot also, he had doubts as to its truth. Assuming its truth, however, he carried Carnot's reasoning much further, and deduced from the Carnot cycle a thermometric scale which was absolute in the sense that it defined the idea of temperature independently of the properties of any particular body.

It is very difficult to carry one's mind back to the material theory of heat, but it is necessary to do so in order to appreciate the rigid accuracy of the reasoning of both Carnot and Thomson; and it is especially desirable to do so in order to understand the great step made in this Paper. According to the "caloric" theory, heat was supposed to be a subtle elastic fluid which permeated the pores of bodies and filled the interstices between the molecules of matter. The fundamental quality imagined of this caloric or heat fluid was that of indestructibility and uncreatability by any humanly controlled process. Bodies became warmer when caloric was added to them, and grew colder as it left them. Caloric, however, might be added to a body without heating it. In this case the heat was called "latent," and the state of the body changed from solid to liquid or from liquid to vapour or gas.

Caloric, too, was required in greater quantities for some substances than others in order to warm the body equally. The capacity for caloric was thus greater in some bodies than in others.

If any particular body were heated without change of state it was hotter; that is, its temperature rose when the quantity of caloric present was increased. It was not difficult to define equality of temperature. This was defined by a constant condition when brought into contact. But it was very difficult indeed to define temperature on any rational scale.

To the acute and brilliant intellect of William Thomson it became apparent that he had in the Carnot cycle a powerful instrument capable of widely general use, apart altogether from the theory of heat engines; and he here uses it in a most skilful way to give definiteness and universal application to the idea of temperature, as Prof. Larmor states, "elevating the idea of temperature from a mere featureless record or comparison of thermometers into a general principle of physical nature."

Thomson accordingly defines equal differences of temperature in terms of the reversible or Carnot engine.

Equal temperature differences are to be differences between the temperatures of the source of heat and the refrigerator, when the proportion of work produced from a given quantity of heat is the same. Thermometers graduated in degrees calculated in this way could naturally be treated as instruments based on definite principles, independently of any properties of any particular material. The idea of temperature here was in rigid logical consistency with the "caloric" theory of heat, and it carried out completely the analogy between power derived from the same quantity of heat falling from a higher to a lower level, and resembling a fall of water in producing its effects. For equal quantities of "caloric," as of "water," temperature fall was regarded as similar to fall in space, and so an accurate idea of the nature of temperature difference is attained.

This definition, however, gave a scale greatly differing from that of mercurial, air, and other thermometers, the degrees defined by it corresponding to larger and larger intervals on the air thermometer as temperature increases. Prof. Tait pointed out also that on such a scale the temperature of a body totally deprived of heat is negative-infinite.

All these difficulties do not detract from the fundamental importance of the idea here enunciated for the first time: the idea of an absolute thermometric scale theoretically applicable to all bodies—solid, liquid, and gaseous. On the "caloric" or "material" theory of heat, motive power is obtained during the letting down or fall from a higher to a lower level of a given quantity of heat. The quantity of heat does not alter in the process: it is only its relative level which alters. There is no reason, therefore, for mentally limiting the amount of mechanical energy obtainable from any given quantity of caloric, just as there is no reason for limiting the amount of mechanical energy to be mentally derived from a given weight. Any desired quantity of energy may be derived from a weight of, say, one pound, if it only be allowed to fall far enough, assuming gravity to be constant through the range.

The investigation of the work to be derived from a given quantity of heat at a given temperature is thus a matter of experiment, which can be settled by measurement of the properties of a few bodies.

Reasoning, it is conceived, in this way, Thomson follows up his absolute thermometric scale work with an investigation entitled "Carnot's Theory of the Motive Power of Heat," described in a Paper read in 1849 before the Royal Society of Edinburgh, in which he calculates from Regnault's experiments on steam the power developed by a Carnot reversible engine when using one centigrade heat unit; that is, the heat necessary to heat one pound of water through 1° C. for temperatures from 1° to 231° C., the temperature falling in the engine in each case to 0° C.

In this Paper he asks himself two questions: (1) What is the precise nature of the thermal agency by means of which mechanical effect is to be produced without effects of any other kind? and (2) How may the amount of the thermal agency necessary for performing a given quantity of work be estimated?

Using Regnault's values for the properties of steam, he calculates the lines of compression and expansion without heat loss, the lines of compression and expansion with heat flow at the lowest temperature, and heat addition at the highest temperature, and thus arrives at the work area per heat unit let down. He tabulates these results, and shows that what he calls Carnot's function diminishes as temperature rises, using the ordinary centigrade scale. On the caloric theory the methods are rigidly logical and correct, but some inaccuracy is introduced by the necessity of that theory for the discharge of the same amount of heat at the third operation as is taken in on the first. The Paper is of great interest, however, because it shows clearly how fully the distinguished author realises the necessity for re-examining the standard ideas of the nature of heat. Two paragraphs make this very clear:—

"7. Since the time when Carnot thus expressed himself the necessity of a most careful examination of the entire experimental basis of the theory of heat has become more and more urgent. Especially all those assumptions depending on the idea that heat is a substance, invariable in quantity, not convertible into any other element, and incapable of being generated by any physical agency: in fact, the acknowledged principles of latent heat would require to be tested by a most searching investigation before they ought to be admitted, as they usually have been, by almost everyone who has been engaged on the subject, whether in combining the results of experimental research or in general theoretical investigations.

"8. The extremely important discoveries recently made by Mr. Joule, of Manchester, that heat is evolved in every part of a closed electric conductor moving in the neighbourhood of a magnet, and that heat is generated by the friction of fluids in motion, seem to overturn the opinion commonly held that heat cannot be generated, but only produced from a source where it has previously existed either in a sensible or in a latent condition. In the present state of science, however, no operation is known by which heat can be absorbed into a body without either elevating its temperature or becoming latent, and producing some alteration in its physical condition; and the fundamental axiom adopted by Carnot may be considered as still the most probable basis for an investigation of the motive power of heat, although this, and with it every other branch of the theory of heat, may ultimately require to be reconstructed upon another foundation when our experimental data are more complete. On this understanding, and to avoid a repetition of doubts, I shall refer to Carnot's fundamental principle, in all that follows, as if its truth were thoroughly established."

In these two paragraphs Thomson sums up the whole situation in 1849, and promises further investigation and further attempts to deduce the nature of the connection between heat and work.

Assume, then, the truth of the caloric theory of heat, as Thomson does in the 1849 Paper: We have a complete theory of the heat engine, based on the Carnot cycle, accounting for efficiencies which vary with temperature differences, but requiring no definite mechanical equivalent of heat; nay, antagonistic to the existence of such an equivalent. The caloric theory, as has been pointed out, is quite consistent with the theoretical possibility of obtaining an indefinitely great amount of mechanical energy from any given quantity of heat, provided the *letting down* or fall of level be indefinitely great.

At the time we are discussing—1850—the bare conception of the idea of an absolute zero of temperature is one which is startling in its boldness; and it must have been difficult indeed then to imagine any definite line of proof which could be followed to establish the real existence of such a physical limit. We are so familiar with the existence of very high temperatures, vastly transcending the temperatures in which we personally exist, that we can hardly conceive a temperature limit on the ascending side; that is, we can hardly think of any given high temperature which could not in quite conceivable circumstances be exceeded. We know, for example, that any metal—say platinum—may be melted if its temperature be sufficiently increased; that a further sufficient increase will convert the liquid metal to the gaseous state, and that the gaseous metal may be heated indefinitely while in that state. We know the behaviour and properties of many substances at high temperatures, and are aware of the strong tendency of all chemical compounds, when highly heated, to split up into the elementary bodies composing them. All this we appreciate, but we find it difficult to see how a point of temperature could be reached when it could be said: This is a physical limiting point on the ascending scale; we may heat a substance up to this temperature, but it is impossible to conceive of any higher temperature. It is necessary here to distinguish between a conceivable limit to an ascending temperature and a practical limit under existing conditions. We may thus place limits, say, to the temperature of coal-gas and air explosions, or the temperatures possible from the electric arc; the limit with coal gas and air depending on one set of conditions, and the electric arc upon another set, such as the vapourising point of carbon, and so on. In the same way, at the middle of last century it would have been considered quite reasonable to suppose that human existence was carried on at an intermediate plane of temperature, and that temperatures might exist as low, relatively to our mean temperature, as our known furnace and combustion temperatures are high. At this time, no doubt, such an idea was quite a reasonable one.

No such limit could be proved, even by the aid of the Carnot cycle, reasoning on the material theory of heat. If we assume that heat is material, and that in some way temperature fall doing work resembles, as Carnot supposed, the fall of water doing work in passing from a higher to a lower level, then no absolute zero is possible, because the same quantity of heat is supposed to exist at the low as at the high temperature. On this theory nothing in the idea of temperature suggests a possible physical limit. On the material theory, the notion of temperature is one to which it is exceedingly difficult to attach a precise meaning.

Thomson's promises of further investigation were fulfilled in 1850, in which year he definitely accepted the dynamical theory of heat and finally abandoned the material. His conclusions are given in a Memoir of the first importance which was read before the Royal Society of Edinburgh in 1851. It was entitled "On the Dynamical Theory of Heat." Before dealing with it, however, it is desirable to consider the work of Joule and others on another side of thermodynamics.

Long before 1850 the equivalence of mechanical work and heat quantity had been accepted by many scientific men, and Rumford had, indeed, made measurements of a rough kind. It remained, however, for Joule experimentally to determine the mechanical equivalent in the most accurate manner and place what is now known as the first law of thermodynamics upon the sure basis of absolute experimental determination. His first Paper was read before the Cork Meeting of the British Association in 1843, and at the Oxford Meeting in 1847 he read another —"On the Mechanical Equivalent of Heat"—describing the results of experiments with paddles rotating in liquids driven by falling weights. By these years of work he had absolutely demonstrated the equivalence of heat quantity and mechanical work, so that no loophole of escape seemed possible; it appeared as if the material theory was rendered intellectually impossible to the trained intellect. This was not the fact, however, as is evident from both Joule's and Thomson's accounts of that British Association Meeting.

Joule's earlier Paper had been coolly received. Indeed, it is evident that the idea of a mechanical equivalent of heat was still distasteful to the physicists of the day, and its discussion was looked upon with dislike. Joule, at the 1847 Meeting, addressed a small audience, and the account of his experiments was received without enthusiasm. This adverse atmosphere, so discouraging to the investigator, was quickly removed, however, when a young man rose to make his remarks, and, by his enthusiastic comment and clear reasoning, at once succeeded in attracting the interest of those present. This young man was William Thomson, Professor of Natural Philosophy in the University of Glasgow. Speaking of this, his first meeting with Joule, at Manchester forty-six years later, Lord Kelvin said: "I can never forget the British Association at Oxford in the year 1847, when in one of the Sections I heard a Paper read by a very unassuming young man, who betrayed no consciousness in his manner that he had a great idea to unfold. I was tremendously struck with the Paper. I had first thought it could not be true because it was different from Carnot's theory, and immediately after the reading of the Paper I had a few words of conversation with the author, James Joule, which was the beginning of our forty years' acquaintance and friendship. . . . I gained ideas which had never entered my mind before, and I thought I, too, suggested something worthy of Joule's consideration when I told him of Carnot's theory." This Meeting was indeed fateful for the future of the science of thermodynamics, as it resulted in cooperation between two men of giant intellect, who between them performed most of the experimental work which was necessary to make thermodynamics an exact science. Their work alone sufficed to place the first and second laws of thermodynamics on the firm footing of accurate experiment and logical deduction.

Although Thomson was much struck by Joule's experiments, he did not accept the dynamical theory of heat at once. As he stated himself: "I had first thought that it could not be true because it was different from Carnot's theory."

Joule's discoveries at this date may be thus expressed:—

Heat and mechanical energy are mutually convertible, and heat requires for its production, and produces by its disappearance, mechanical energy in the proportion of 1390 foot-pounds for each centigrade heat unit, a heat unit being the amount of heat necessary to heat one pound of water through 1° C.

Knowing, as Thomson did, that mechanical energy could be produced by the agency of heat, but that its amount varied with the temperature and temperature fall, Joule's discoveries seemed antagonistic to Carnot's demonstration; and, convinced as he was that Carnot's law was true, he naturally felt at first that there must be some other way of looking at Joule's results than that adopted by Joule himself.

Joule naturally believed in his own manner of looking at his results, and he apparently agreed with Thomson as to the antagonism between what may be here called the Carnot and Joule laws.

The material theory of heat might have been true; in which case there was no more need for any direct quantitative connection between heat quantity and mechanical energy than between the mass of a body and its mechanical energy. Any unit of mass may acquire any conceivable amount of mechanical energy if its velocity be great enough, and so any unit of heat on the caloric theory may produce any conceivable amount of mechanical energy if the temperature fall be great enough. Joule considered the Carnot law to be so inconsistent with his law that in one of his Papers he proposes its abandonment as inconsistent with discovered facts. At this point the two ideas seem to be in opposition. The germ of reconciliation, however, is found in observations by Thomson in both the 1848 and 1849 Papers. In paragraph 8, quoted here from the latter Paper, it is stated:—

"In the present state of science, however, no operation is known by which heat can be absorbed into a body without either elevating its temperature or becoming latent and producing some alteration in its physical condition."

This is equivalent to saying that no case has been observed where heat disappears doing mechanical work. In a note occurring in the same Paper he alludes to the fact that engineers always assume that the amount of heat found in the condenser of the steam engine was the same as that taken into the engine by the steam, in the following terms:—

"So generally is Carnot's principle tacitly admitted as an axiom that its application in this case has never, so far as I am aware, been questioned by practical engineers."

This was quite accurate. Hirn's demonstration that heat disappears in a steam engine when work is done was not made until 1857, eight years later.

In the 1848 Paper he states:—

"The experiments of Mr. Joule of Manchester seem to indicate an actual conversion of mechanical effect into caloric. No experiment, however, is adduced in which the converse operation is exhibited; but it must be confessed that as yet much is involved in mystery with reference to these fundamental questions of natural philosophy."

Here we find Thomson's mind engaged—in 1848 and 1849—with the very matter requiring proof. Joule had proved the generation of heat by means of mechanical work; Thomson required the proof of the converse case—the disappearance of heat when mechanical work was done by the working fluid.

This proof was forthcoming in the results of experiments on the compression and expansion of air. Accordingly, we find the Carnot and Joule principles reconciled in Thomson's Paper of 1851, and the important deduction made of an absolute zero of temperature at $-273°$ on the centigrade scale. The introduction of the idea of the mechanical equivalent of heat leads at once to an absolute zero of temperature, and allows of the determination of this physical lower limit by the use of the Carnot cycle for investigating the efficiency of a perfect engine using any working fluid. Air was the working fluid actually investigated, and the determination of its properties at ordinary temperatures was a vitally important result of the cooperation of Thomson and Joule. Their experiments lasted for many years, and their rigorous investigation disclosed the fact that internal work was done in expanding a gas; in fact, that in a gas expanding isothermally doing work, part of the heat only disappeared in external work and part was absorbed in separating the molecules.

The Joule and Carnot laws are now known as the first and second laws of thermodynamics.

The second law, in modern form, may be thus stated:—

Although heat and work are mutually convertible and in definite and invariable proportions, yet no conceivable heat engine is able to convert all the heat given to it into work. Apart altogether from practical limitations, a certain portion of the heat must be passed from the hot body to the cold body in order that the remainder may assume the form of mechanical energy.

The proportion of the total heat convertible into mechanical energy depends on the absolute temperatures of the hot and cold bodies; it is unity *minus* the lower absolute temperature upon the upper absolute temperature.

It appears that during Thomson's struggle to reconcile the two apparently opposing laws, Clausius, who had seen the same difficulty, arrived independently at its solution and published a Paper, "On the Motive Power of Heat and the Laws of Heat which may be deduced therefrom," at the Berlin Academy in February, 1850. In this Paper, Clausius discusses Thomson's difficulties, and also arrives at the conclusion that the Carnot cycle may be reconciled to Joule's law by the omission of the supposition that during the third process the same amount of heat is discharged from the cool body as was taken in from the hot one. He states :—

"On a nearer view of the case we find that the new theories were opposed not to the real fundamental principle of Carnot, but to the addition that no heat is lost. For it is quite possible that in the production of work both may take place at the same time: a certain portion of heat may be consumed and a further portion transmitted from a warm body to a cold one; and both portions may stand in a certain definite relation to the quantity of work produced. This will be made plainer as we proceed; and it will be moreover shown that the inference to be drawn from both assumptions may not only exist together, but that they may mutually support each other."

In his 1851 Paper, Thomson gives Clausius full credit for solving the difficulty between the Carnot and the Joule principles. Thomson gives Clausius the full credit for priority, but states that he was working on the same problem and had arrived at the same solution in the year 1850, before he had seen Clausius' work. Clausius, however, assumed the theory of a permanent gas, which required the absence of internal work, but Thomson was not prepared to assume this without experiment. This determination rigidly to prove every necessary assumption, and his clear conception of the points necessary for proof, led to the extensive series of researches undertaken by Thomson and Joule with the object of determining how much gas thermometers differ from an absolute scale as determined by the combination of the Joule and Carnot laws.

Rankine, as early as 1849, arrived at the general equation of thermodynamics which expresses the relation between heat and mechanical energy, and indicated the result of his investigations to the Royal Society of Edinburgh in February, 1850. Rankine thus arrived independently at the same result as Clausius about the same time. Both Rankine and Clausius, however, adopted certain theories as to the molecular structures and motions of gases, and their demonstrations to some extent depended upon their theories. To Thomson and Joule we are deeply indebted for the rigid proof of the two laws and for the rigid deduction of the modern scale of temperature and the determination of absolute zero in its modern form. Thomson now thus defines temperature :—

"The temperatures of two bodies are proportional to the quantities of heat respectively taken in and given out in localities at one temperature and at the other respectively, by a material system subjected to a complete cycle of perfectly reversible thermodynamic operations, and not allowed to part with or take in heat at any other temperature; or, the absolute values of two temperatures are to one another in the proportion of the heat taken in to the heat rejected in a perfect thermodynamic engine, working with a source and refrigerator at the higher and lower of the temperatures respectively."

This definition leads to an absolute scale of temperature which is independent of the substance operated on, and Joule and Thomson's experiments have shown that this scale differs but slightly from that of the ordinary air thermometer. Joule had suggested to Thomson, in a letter to him in 1848, that the probable value of Carnot's function is the reciprocal of the absolute temperature as measured on a perfect gas thermometer.

Thus Clausius appears to have anticipated Thomson, not in the suggestion of an absolute scale of temperature, but in the idea of an absolute zero founded upon the combination of Carnot's law and Joule's law. Thomson, in his Papers, very modestly attributes the second law—the law of the transformation of heat—to Carnot and Clausius; but in this he undervalued his work, because Clausius appears to have assumed what Thomson and Joule proved; that is, the coincidence of the absolute scale with the air thermometer scale.

It will thus be seen that the position usually assumed by the engineer at 1850, of the equality between heat given to the engine and heat given to the condenser, was fundamentally untrue. Without this deduction, however, no determination of values of the Carnot function could have led to the determination of an absolute zero. According to the material theory, as seen in the light of Carnot's cycle, a heat unit could give an indefinitely increased amount of work with lowering of the temperature. Nothing in the theory sets a limit to this increase, and, accordingly, there is nothing to suggest an absolute zero. Immediately, however, we accept the dynamical theory of heat we find that a pound of water requires the exertion of 1390 foot-pounds of work to heat it through 1° C. We also know from the Carnot cycle that under ordinary conditions of human existence only a portion of this work can be returned; but as no conditions could conceivably exist in which a greater amount of work could be obtained from a pound of water than the 1390 foot-pounds put into it to heat it through 1° C., it follows that, inasmuch as the Carnot function increases with diminishing temperature, the limit of temperature is reached when, according to the Carnot cycle, the whole of that work, put into the pound of water, can be got out again as work. This limit is the absolute zero of temperature. No lower temperature is conceivable without introducing the idea of the creation of energy. So far as human beings are concerned, this idea is as inconceivable as the idea of the creation of matter. The determination of this limit with the close accuracy necessary for a well-founded constant is to be entirely attributed to Thomson and Joule. In his 1851 Paper Thomson thus succeeds in answering the questions which he put to himself in his 1849 Paper, and he supplies a quantitative method of connecting the amount of the thermal agency necessary with the amount of work which can be performed under varying conditions.

Engineers dealing with motive power are thus deeply in debt to Thomson and Joule for the secure position occupied by them to-day.

The brilliant work of Meyer, published so early as 1842, is held by some to have anticipated to a large extent both the work of Thomson and of Joule. Undoubtedly Meyer formulated true ideas and carried his generalisations through a wide range. Helmholtz also very early arrived at similar conclusions to those of Joule and Thomson; but it has been thought better to discuss the work of Thomson and Joule separately, in order to illustrate the transition period through which many distinguished minds were passing about the time. Undoubtedly great credit is due to Meyer, Helmholtz, Clausius, and Hirn, and Thomson himself recognised this in the most generous way.

The ideas of Thomson and Joule now form so much of the basis of all reasoning upon motive-power engines that there is some little danger to the present generation of forgetting what they owe to these two great men. To appreciate the step made by them it is necessary to consider the position of motive power produced by heat at about the middle of the last century. At that time many attempts had been made to displace the steam engine as a heat engine by air engines in various forms—both engines heated externally and those heated internally, now known as internal-combustion engines. Papers read at the Institution of Civil Engineers in 1845 and 1853, and the discussion of those Papers by eminent men of the day, supply an accurate measure of the knowledge possessed by the engineer of the principles of action of his heat engines. Many distinguished names occur in these Papers and Discussions, including James Stirling, Robert Stephenson, Sir George Cayley, Charles Manby, James Leslie, C. W. Siemens, Hawksley, Pole, W. G. Armstrong (afterwards Lord Armstrong), Edward Woods, E. A. Cowper, D. K. Clark, Benjamin Cheverton, Goldsworthy Gurney, George P. Bidder, Prof. Faraday, Isambard K. Brunel, Captain Fitzroy, and F. Braithwaite. At the date of the later of these discussions Brunel had already designed the *Great Eastern*, in 1852, with its engines of 11,000 horse-power. Armstrong was a Fellow of the Royal Society, and had started the Elswick Works and invented the Armstrong gun. Robert Stephenson was at the height of his fame. He was then a Member of Parliament, President of the Institution of Civil Engineers, and a Fellow of the Royal Society. Siemens was a young man, but was busy on the regenerative furnace; had considered regeneration as applied to steam engines, although his work on the air engine was still to come. All were distinguished men in their day, and their opinions may be taken as representing the very best scientific knowledge of the leading engineers of the day. The first of the Papers to which I refer is called "Description of Stirling's Improved Air Engine," by James Stirling, M.Inst.C.E. It was read on June 10, 1845, with Sir John Rennie, the President of the Institution, in the chair. The engine described was the later form of the well-known Stirling air engine, invented by the Rev. Dr. Stirling, a Scottish clergyman, in the year 1815. The development considered was the invention of the reader of the Paper, a brother of Dr. Stirling. The main improvement consisted in the use of air at a greater density than the atmosphere, and the engine at that date had so far succeeded that two had been used at the Dundee Foundry Company's works—one giving about 21 horse-power and the other about 45 horse-power. Practically, therefore, some success had been attained. Mr. Stirling claimed that the 21-horse engine consumed 50 lb. of coal per hour, which is about $2\frac{1}{2}$ lb. per horse-power per hour. This was an extraordinarily good result for the time. At present, however, we are not interested in the practical result, but only in the opinions of the engineers of the day as to the fundamental principles of heat engines.

It is clear from the Paper that the theory of the regenerator was entirely misunderstood. It was imagined that with a perfect regenerator no heat would be required to perform work. This is evident from Mr. Stirling's answer to Sir George Cayley. Sir George Cayley described his engine, which was of the internal-combustion type, acting with solid fuel under constant pressure, and showed that, owing to dust and heat in the cylinder and valves, his experiments proved abortive. He stated, however, that his engine had consumed $6\frac{1}{4}$ lb. of coke—equal to 9 lb. of coal—per horse-power. To this Mr. Stirling answered: "It must be remarked that Sir George Cayley, in following an entirely different object, had overlooked the great leading principle of repeatedly using the same heat," and "he was of opinion that, except on that principle, the air could not be economically used as a moving power." Another speaker, Mr. Cottam, said: "It was evident that, if it was practicable to arrive at the theoretical condition of the absorption of all the caloric by the thin laminæ during the upward passage of the air and the giving it out again during the downward passage, there would not be any loss of heat." Mr. Robert Stephenson did not appear to understand Stirling's air engine at all, because he made the following remarks: "He understood the process to consist of heating the air in a vessel, whence it ascended to the cylinder between numerous thin laminæ, by which the caloric was absorbed, to be again given out to the descending air. Now it appeared to him that, though the ascending process was natural and easy, the reverse action would require a certain expenditure of power, in the depression of the plunger." This remark clearly showed that Stephenson, notwithstanding his eminence as an engineer, at that date had not appreciated the essential conditions of the hot-air engine.

In the year 1853 the subject of the air engine again came up before the Institution of Civil Engineers, interest being excited evidently by the building of the large engines of the hot-air ship *Ericsson* in America, the engines having air cylinders of no less than 14 feet diameter. Four Papers were read in this year: "On the Use of Heated Air as a Motive Power," by Benjamin Cheverton; "On the Caloric Engine," by Charles Manby; "On the Principle of the Caloric Air Heated Engine," by James Leslie, M.Inst.C.E.; and "On the Conversion of Heat into Mechanical Effect," by Charles William Siemens, A.M.I.C.E.

Cheverton evidently considers, from his Paper referring to Stirling and Ericsson, that "Both parties also rest the efficiency of their engines on the repeated use of caloric. They contend that in recovering from the ejected hot air the caloric which gave it superior tension, and employing it in heating the injected air, 'it is made to operate over and over again.' Mr. Ericsson aspires to embody a new principle in motive mechanics—no less, to use his own words, than 'that the production of mechanical force by heat is unaccompanied by the loss of heat,' except such as arises from radiation, or other practically unavoidable waste." Cheverton rejects this idea, but, strangely enough, does not appear aware of the work either of Carnot or of Joule. He comes to the conclusion, however, that "caloric, doubtless, is in all its aspects a manifestation of force, and unquestionably, as a mechanical agent, of a dynamic force, and therefore is directly amenable to the third law of motion." He appears to think that heat is accompanied with molecular activity, but is puzzled by what he accepts to be a fact, that in the steam engine the whole of the heat of the steam as it comes from the boiler is found in the condenser. With regard to the steam, he says: "Undoubtedly, in respect to the materiality of caloric, if it be material, it is transferred intact to the condenser, yet in its passage it may have parted with force, which it cannot communicate again." He comes to the conclusion that the change may take place, not in the quantity, but in the intensity of heat. Here he resembles Carnot; but it appears to him impossible to arrive at any useful theory of the heat engine, because he states: ". . . for every investigation leads to the conclusion that the effect of caloric is independent at least of the chemical, if not also of the physical, constitution of bodies. But economy of fuel is a different question from the economy of caloric; it is altogether a practical matter, and can only be determined by experiment; for this, and, indeed, most other points of practice, are too intractable to come within the grasp of the most powerful calculus." In the discussion a communication was read from Sir George Cayley, in the course of which he states, with regard to the regenerator: "There can exist no doubt of the effective re-application of heat to an almost unlimited extent by this beautiful invention, due originally to Mr. Stirling, and now carried out to a greater extent by Captain Ericsson." Sir George Cayley discussed the difficulties of Ericsson's engine, but he accepts the principle that heat may give work and yet be used over and over again practically undiminished. Armstrong did not express himself upon the theory at all, but he was doubtful as to the advantage of the air engine compared with the steam engine, although he believed that it was practicable to recover and use over again a large proportion of the heat applied, and he thought the balance of economy, so far as heat was concerned, would be found in favour of air. Siemens agreed to some extent in the advantages of a regenerator, but he showed clearly that expansion doing work was accompanied by a diminution of temperature, and stated that this heat had to be replaced by the fire. Bidder was of opinion "that no theoretical advantage was obtained in using heated air instead of vaporised water as a motive power, and it was incapable of being applied practically with as much convenience." It is most interesting to note that Dr. Faraday joined in this discussion. He said very little, and I will give his remarks complete. Dr. Faraday said: "Twenty years ago he had directed his attention to this question, and from theoretical views he had been induced to hope for the successful employment of heated air as a motive power; but even then he saw enough to discourage his sanguine expectation, and he had, with some diffidence, ventured to express his conviction of the almost unconquerable practical difficulties surrounding the case, and of the fallacy of the presumed advantages of the regenerator. He still retained his doubts as to the success of the innovation, and feared the eventual results, even of Captain Ericsson's spirited and ingenious efforts." Brunel considered the use of the regenerator to be an entire fallacy, and did not believe that the power derived from the expansion of air by heat could be used effectively, and then be recovered and used again. Mr. Hawksley considered that the machine involved a mechanical fallacy and that the regenerator produced no mechanical effect whatever. Mr. Rendel was the President at the Meeting which dealt with Mr. Cheverton's Paper, and, in view of the great differences of opinion on the subject, he stated that "he would not have the Meeting arrive at a hasty or erroneous conclusion on the question of this engine, and he therefore suggested that Mr. Siemens should draw up a Paper on the subject, and that the Members should collect, for a future Meeting, all the information within their reach in order to the calm and deliberate discussion of the question." This resulted in the further Meeting of May 17, 1853, when Papers were read by Manby, Leslie, and Siemens. The Paper by Manby consists of the summary of a discussion by M. Galy-Cazalet, which took place in Paris in 1852. M. Galy-Cazalet comes to the conclusion that the regenerator involves a fallacy, and he concludes: "There appears to be at present so much doubt of the utility of the regenerator that it would be wise to abandon its use for a time, and by trials with a more simple form of caloric engine establish the fact either of the superiority or of the inferiority of heated air in comparison with steam as a motive power." Mr. Leslie, on the contrary, in his Paper upholds vigorously the accuracy of the principle of the regenerator or economiser. He comes to the conclusion that it is based on true principles and is attended in practice with real economy of heat, and consequently of fuel. In this conclusion he is doubtless correct; the regenerator is useful and does economise heat. But Leslie goes much further than this; he appears to support Stirling in the fallacy that the regenerator may be made indefinitely useful. Stirling states:—

"And thus it appears that by applying air successively to a series of bodies regularly increasing in temperature, and moving it alternately from one end of the series to the other, it may be heated and cooled ten times, with an expenditure of caloric which would barely have heated it once, if it had been applied at once, to the hottest body (*i.e.* beyond the series). It is evident also that if the series had been composed of twenty points, or bodies, having a difference of temperature of five degrees, the air might be heated and cooled twenty times at no greater expense of caloric. Nay, it is evident that by multiplying the members of the series indefinitely air could be heated and expanded and made to do work at no appreciable expense. But let no mathematician be alarmed with the idea of a perpetual motion, or the creation of power. There are many enemies to contend with in the air engine besides friction, which alone prevents perpetuity in some mechanical motions. We have no means, without consuming a part of our power, of applying the air so closely to the apparatus as to make it absolutely assume the temperature of the bodies to which it is applied. There is, therefore, a loss in the very act of heating and cooling."

Leslie comes to the conclusion that Stirling is right, but that an air engine without a regenerator would be a much less effective and economical application of heat than the steam engine. Leslie gives some interesting particulars of the later air engines of James Stirling. He states that an engine of 45 horse-power was started in March, 1843, at the Dundee Foundry; that in December, 1845—two years and nine months after starting—one air-vessel gave way, and in May, 1846, another failed, and in January, 1847, a third failed. This information was supplied to him by Mr. David Mudie, one of the lessees of the foundry.

We now come to Siemens' Paper "On the Conversion of Heat into Mechanical Effect," and for the first time we find the engineer guided by an intelligible principle. Siemens discussed the material theory of heat, and accepted unreservedly the dynamical theory, for which he gives a large measure of credit to Joule. This is the first of the Institution Papers in which I find the name of Joule. Siemens mentions Carnot, Clapeyron, Holtzman of Mannheim, Joule, Helmholtz, Meyer, Rankine, and Prof. Thomson. Curiously enough, although Siemens mentions Carnot and the other philosophers who dealt with the Carnot principle, including Thomson, he does not appear at this date—May 17, 1853—to have realised himself the effect of the law of Carnot upon the theory of the heat engine. He clearly appreciated the first law, and gives the mechanical equivalent of heat as determined by Joule at 770 foot-pounds, and by Thomson's formula as 772 foot-pounds, but in his discussion of the principles of the heat engine he is of opinion that a perfect engine is ideally possible giving 770 foot-pounds for each Fahrenheit heat-unit employed. This is clear from a Table found on p. 33 of the Paper, which I reproduce:—

Siemens' Table of 1853.

| Description of Engine | Theoretical Performance in foot-pounds | Actual Performance in foot-pounds | Actual Performance in pounds of Coal per H.P. per Hour. |
|---|---|---|---|
| A Boulton and Watt condensing engine, low pressure ... ... ... ... | 51·8 | 29 | 8·00 |
| The best Cornish engine ... | 158·8 | 82 | 2·38 |
| Combined steam and expansive ether engine ... | 150·0 | 75 | 3·09 |
| The expansive air engine ... | 91·0 | 35 | 6·63 |
| Stirling's engine ... ... | 130·0 | 65 | 3·57 |
| Ericsson's engine ... ... | 196·0 | 65 | 3·57 |
| A Perfect engine ... ... | 770·0 | 385 | 0·00 |

He apprehends the mechanical equivalent of heat, but he still appears under the impression that if heat be added to a certain upper temperature and expansion take place until the original temperature is reached, then he has a perfect engine indicating the full result of Joule's mechanical equivalent. He sees, however, that the old theory of the regenerator is quite wrong. He states:—

"The cause of the failure of Mr. Stirling's engine in practice may apparently be traced chiefly to insufficiency of heating surface, occasioned apparently from misapprehension of the principle involved, it having been thought that the same heat would serve over and over again to produce power, and that the necessary expenditure of heat consisted only in the mechanical loss by imperfect action of the respirative plates, which were approached to each other to the utmost limits, consistent with an unobstructed passage of the air. By the aid of the dynamical theory of heat it has been shown that there is another and far more important expenditure of heat, which should have been provided for."

Siemens, in the discussion, rightly upheld the regenerator as useful, and saw that there were limitations to its use. Mr. Hawksley contended that the regenerator was useless. Mr. Pole considered that the regenerator was useful, but he did not definitely adopt the mechanical theory of heat. He stated:—

"It must be allowed that the general action of caloric in producing power was still involved in much obscurity. The heat was often considered in reference to its quantity only, but it was certain also that its intensity performed a very important part; and it had even been surmised that power might be obtained by the reduction of intensity alone, without any change of quantity."

Armstrong concurred with Siemens and Pole. He believed in the utility of the regenerator, limited as described by both. Mr. Edward Woods certainly understood Siemens to have given 772 foot-pounds as the efficiency of an ideal heat engine, because he stated that this showed there was still great room for improvement in engines. Mr. E. A. Cowper had clear ideas; he said:—

"Steam, or gases, in expanding, and so giving out power, lost heat. Part of the sensible heat became latent in the production of power, and this heat could only be recovered by expending the power already produced in again condensing the steam back to its original bulk, when the latent heat again became sensible."

This discussion, then, puts us in the position of engineers at the date of the last Meeting referred to—May 17, 1853. Of all the distinguished engineers who spoke, Siemens alone had thoroughly apprehended the value of Joule's results and understood the full bearing of the mechanical equivalent of heat. He had not, however, understood Carnot's reasoning on the Carnot cycle, or Thomson's deductions from Carnot. He was under the impression that heat added in any way to a working fluid, raising the temperature, could be entirely converted into work by a sufficient expansion. He had not appreciated that, even if expansion be carried far enough to reduce the temperature to the original temperature before heat addition, yet complete conversion of the entire mechanical equivalent was impossible. When so able a man as Siemens had at this stage only reached partial enlightenment, it was evident that much hard work and clear thinking required to be done before a well-founded theory of heat motive-power could be obtained. The data for such a theory were accumulating; and one of the most interesting circumstances connected with these Institution of Civil Engineers Papers was a communication from M. Regnault to Colonel Sabine, Treasurer of the Royal Society, dated April, 1853, which was read at the Meeting, in which Regnault stated that

"He was about to publish immediately a series of elaborate experimental researches on various subjects connected with the effects of heat on elastic fluids, the results of which would solve many questions long in dispute, and by means of which engineers might accurately calculate the effect of a given amount of fuel, in whatever way it was applied. M. Regnault communicated in anticipation that he had arrived at the number 0·237 for the specific heat of air at constant pressure, and at 0·475 for that of steam under atmospheric elasticity, the specific heat of water being taken in each case as unity."

True to his word, Regnault produced his admirable investigations, and succeeded in solving many problems; but he did not settle the questions to the extent he had hoped. Even at the present time doubt arises as to the very values he gave for the specific heat of air and steam. The problem proved much more difficult than he had anticipated, and for modern engine purposes it cannot be considered as wholly solved now—fifty-five years later.

This description of the position of the hot-air engine, as shown by the opinions of eminent engineers, is most useful as proving how much practical men were in need of the work of Thomson and Joule. It is not surprising that, of all the engineers present, Siemens appeared to be alone in thoroughly grasping the new ideas. Thomson's own conversion from the material theory of heat to the dynamical theory was not complete until 1851, and although he had then succeeded in reconciling the ideas of Joule and Carnot, it is not to be wondered at that engineers two years later had not quite succeeded in grasping the combination of the two laws. This combination, however, supplied engineers with a new and accurate standard of measurement for studying and improving upon their heat engines, and they were by no means slow in grasping the help thus offered them by the abstract scientific man. The broad laws of thermodynamics have placed the theory of the heat engine in a position of certainty, which was much needed. It would be a mistake to assume, however, that even the determination of the mechanical equivalent of heat and the second law of thermodynamics expressed in terms of an absolute thermometric scale had solved all the difficulties of the engineer desiring to determine the efficiency of his heat engines. Thomson, Joule, Rankine, and their great Continental colleagues, it is true, settled once and for all the broad laws of thermodynamics, but the Carnot cycle is a cycle which is, as has been repeatedly shown, an impossible one in practice. Accordingly, actual engines have to operate upon imperfect cycles. The theory of these imperfect cycles has been worked out mostly during the last twenty-five years, although Rankine made a beginning in dealing with the theory of the Joule air engine. For the first time he showed the existence of what may be termed a cycle of constant efficiency in the case of the Joule air engine. Assuming constant specific heat for the working fluid, he calculates the efficiency of what we now call a constant-pressure air engine between certain limits of temperature, and he gives the efficiency of the fluid where $U$ = energy exerted and $H_1$ = heat received, and $r$ = ratio of compression and expansion:—

$$\frac{U}{H_1} = 1 - \frac{1}{r^{0 \cdot 408}};$$

that is, he indicates in this formula that the thermal efficiency is independent of the maximum temperature so long as that maximum temperature exceeds the temperature of adiabatic compression. He makes no statement, however, that this engine is within a certain range independent of the maximum temperature; that is, that increasing maximum temperature does not increase efficiency. Subsequent work has shown that, on a simple assumption, such as constant specific heat, many engine cycles exist of a practicable nature having high theoretical efficiencies where the theoretical efficiency depends on one thing only—the ratio of compression. Some misunderstanding has arisen with regard to these imperfect cycles, and it has even been thought that such imperfect cycles would be contrary to the second law of thermodynamics. Lord Kelvin himself was of this opinion in 1881. I vividly remember a conversation I had with him at the Crown Iron Works, in Glasgow, over the results I had obtained from one of my early gas engines. I had then come to the conclusion that the "Otto" cycle as ordinarily operated was a cycle of constant efficiency, and I explained this to Lord Kelvin. He had not followed such cycles, and his view then was that no such cycle could exist, because he thought it was contrary to the second law of thermodynamics. Some idea of this kind has been held by many scientific men, and has prevented the minute investigation of imperfect cycles of different kinds, because of the feeling that the whole question of efficiency was entirely settled by the nature of the temperature limits; that is, by the maximum and minimum temperatures at the disposal of the engineer. It is true that these values, as has been shown, must always determine the extreme limit of possible efficiencies between certain temperatures, and in cycles of constant efficiency the particular efficiency of the cycle is always less than the efficiency of a Carnot cycle engine working between the same limits of superior and inferior temperature. The investigation, however, of these imperfect cycles is much more difficult than the broad investigation of the general thermodynamic laws, because it requires accurate knowledge of the properties of the working fluid dealt with under conditions rendering observation extremely difficult. The modern internal-combustion motor is the successor to the air engine so fully discussed by eminent engineers of fifty-five years ago; and the forebodings of even so eminent a man as Faraday as to its ultimate success have proved unfounded. Great difficulties have been encountered and many discrepancies have had to be explained, but a minute study of the nature of the working fluid has rendered it more and more possible to calculate the efficiencies to be expected under practical conditions. At the present time we can deal with almost any cycle or any working fluid with some fair approximation to an accurate result. Much work, however, is required before all problems of the working fluid can be said to be solved with regard to any heat engine. Indeed, it may be said that under modern conditions of the use of steam even the properties of the working fluid—steam—have not yet been satisfactorily determined. The mere question of specific heat, for example, of steam and its variations of temperature and pressure is now under review, and important experiments are in progress in Britain and on the Continent to determine those properties. The properties of the working fluid of the internal-combustion motor are also the subject of earnest study by many Continental and British investigators. Notwithstanding all the perplexities involved in the minute study of the imperfect heat-engine cycles, we are in a very different position to-day compared with the engineer of 1853. We know all the broad laws as to the conversion of heat into work or of work into heat; and, numerous as are the problems yet to be solved, we at least profit by the guiding light set out for us by Kelvin, Joule, and Rankine.

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## SECTION H.

### ANTHROPOLOGY.

Opening Address by Prof. William Ridgeway, M.A., F.B.A., Litt.D., LL.D., President of the Section.

*The Application of Zoological Laws to Man.*

Thirty years ago in this very city I heard for the first time a Presidential Address at the British Association, and I was singularly fortunate in entering on my novitiate. I had the privilege of hearing Prof. Huxley deliver his Presidential Address to the embryo of that Section over which I, a very unworthy successor, have this day the honour to preside. On that occasion Huxley dealt almost exclusively with the physical evolution of man, and the Neanderthal skull played an important part in his discourse. The anthropologists of that day and since have severely criticised, and rightly so, the old teleological doctrine that everything except man himself had been created for man's use, and they emphatically enunciated the doctrine that man himself has been evolved under the same laws as every other animal. Yet the anthropologists themselves have not always carried out in practice their own principles to their logical conclusions. To-day I shall attempt to show that the chief errors which impede the scientific study of man, which lead to the maladministration of alien races, and which beget blunders of the gravest issue in our own social legislation, are due in the main to man's pride in shutting his eyes to the fact that he is controlled by the same laws as the rest of the animal kingdom.

I. Let us first consider some of the chief problems which at present are being debated by the physical anthropologists. Foremost in importance of these is the stratification of populations in Europe. It has generally been held as an article of faith that Europe was first peopled by a non-Aryan race. Of course it is impossible for us to say what were the physical characteristics of Palæolithic man, but when we come to Neolithic man the problem becomes less hopeless. It has been generally held that the first Neolithic men in Europe, whether they were descended or not from their Palæolithic predecessors, had long skulls, but were not Aryan; that later on a migration of short-skulled people from Asia passed along Central Europe and into France, becoming what is commonly termed the Alpine, by some the Ligurian, by others the Celtic race; that later these two primitive non-Aryan races were overrun by the Aryans, who, when these theories were first started, were universally considered to have come from the Hindu Kush, but are now generally believed, as held by Latham, to have originated in Upper Central Europe. Yet, although the view respecting the cradle of the Aryans has changed, anthropologists have not seen the important bearing that it has upon the problem of Neolithic man. The Aryans are generally held to have had a blonde complexion.

As our discussion must from its nature concern itself with questions of race, let us first examine the criteria by which anthropologists distinguish one race from another. If you ask an anthropologist how he distinguishes an Aryan from a non-Aryan race, he will tell you that he relies on three main tests: (*a*) the colour of the skin, hair, and eyes; (*b*) the shape of the skull and certain other osteological characteristics; and (*c*) the system of descent through males. Formerly language was included in the tests of race, but when it was pointed out that the Negroes of Jamaica speak English, those of Louisiana French, henceforward it was assumed that one race can embrace the language of another with the greatest ease. Yet it may turn out, after all, that language was too hastily expelled from the criteria of race. On the other hand, we may find that too implicit faith has been placed on the three criteria of cranial characteristics, pigmentation, and law of succession.

(*a*) As it is assumed that all Aryans were blonde and traced descent through males, so it is held that all Europeans, who are dark-complexioned, and whose forefathers traced descent through women, are non-Aryan in race, and that, although they now in almost every case speak an Aryan tongue, this is not their primitive speech, but simply that learned from their Aryan conquerors. According to this orthodox view, the dark-skinned inhabitants of Italy, Spain, and Greece are all non-Aryan, and all have borrowed the language of their masters, whilst of course the same is held respecting the melanochrous population of France and of the British Isles. Ever since Prof. Sergi comprehended under what he terms the "Eurafrican species" all the dark-complexioned peoples of Southern and Western Europe, as well as the Semitic and Hamitic peoples of Western Asia and Northern Africa, the doctrine that the dark-skinned peoples of Europe once spoke a non-Aryan tongue or tongues is supposed to have been finally established. But under his Eurafrican species Sergi includes the blonde race of Northern Europe who speak Aryan languages along with the dark races who speak non-Aryan tongues. It is argued that as all the dark-skinned peoples on the north side of the Mediterranean belong by their physical type to the same original stock as the Semites and Hamites, they must likewise have spoken non-Aryan languages. Yet it might as well be maintained that the Finns, who speak a non-Aryan tongue, and the Scandinavians, who speak an Aryan, were originally all of one stock, because both races are blonde.

This doctrine of a Mediterranean race depends upon the tacit assumption made by the physical anthropologists that identity or similarity of type means identity of race. Yet this assumption does not bear the test of scientific examination, for it assumes that only those who are sprung from a common stock can be similar in physical structure and coloration, and it leaves altogether out of sight the effects of environment in changing racial types, and that, too, in no long time. The change in the type of the American of New England from that of his English ancestor and his approximation to the hatchet face and thin, scraggy beard of the Red Indian have long been remarked, whilst the Boers of South Africa, in less than 150 years, have quite lost the old Dutch build, and become a tall, weedy race. The effects of climatic conditions are very patent amongst the native peoples of the New World. The Iroquois of the temperate parts (lat. 40°–45°) of North America were a tall, rather light-complexioned race, but as we keep moving south and approach the equator, their kindred tribes grow somewhat darker in complexion and more feeble in physique, except where they live at a considerable altitude, for of course altitude acts in the same way as latitude. When once we pass below the equator the physique keeps steadily improving until we come to the Pampas Indians, a vigorous race who defied all the efforts of the Spaniards to subdue them; and finally we meet the Patagonians (lat. 40°–53°), a fine, tall, light-complexioned race, who form in the south the counterpart of the Iroquois and their closely allied tribes in the north.

The same law, as is well known, can be seen at work in Europe. Starting from the Mediterranean, we meet in the lower parts a melanochrous race; but gradually, as we advance upwards, the population as a whole is growing less dark, until finally, along the shores of the Baltic, we meet the tallest and most light-complexioned race in the world. Of course it has been explained that the change in pigmentation, as we advance from south to north, is due to the varying proportions in the admixture of the blonde race of the north with the melanochrous of the south. But it is difficult to believe that the movements up or down of the people from the southern side of the Alps, or of those from the shores of the Baltic, have been so nicely proportioned as to give the general steady change from north to south in coloration without the aid of some other force. The case of America, which I have just cited, is in itself enough to raise a suspicion that climatic influences are at work all the time, and that environment is in reality the chief factor in the variation of both stature and pigmentation from the Mediterranean to the Baltic. The white race of the north is of the same proximate ancestry as the dark-complexioned peoples of the northern shores of the Mediterranean. I have already argued elsewhere that, as the ice-sheet receded, mankind kept pressing further north, and gradually under changed climatic conditions the type changed from area to area, and they all still continued to speak the same Indo-European tongue, but with dialectic variations, these also being no doubt due to the physical changes in the vocal organs produced by environment.

If we turn from man to the other animals we find a complete demonstration of this doctrine. For instance, the conditions which have produced a blonde race on the Baltic have probably produced the white hare, white bears, and the tendency in the stoat and the ptarmigan to turn white in winter, whilst in the same regions of Europe and Asia the indigenous horses were of a dun colour, who not only turned white in winter, but had a great tendency to turn white altogether. It may be objected that the Lapps and Eskimo are not tall and blonde, but on the contrary short and dark; but they live within the Arctic circle in regions where the sun does not shine at all for a great part of the year, and consequently they are quite outside the conditions of environment under which the tall, blonde race of North Germany has long dwelt. Of course, in dealing with man we are always confronted with the difficulties arising from his migrations; but if we can find a family of lower animals who cannot be said to have thus migrated, and who show the effects of environment, we shall be able to argue powerfully from analogy.

The horse family supplies the example required. If we follow it from Northern Asia to the Cape of Good Hope, we shall find that every belt has its own particular type, changes in osteology as well as in coloration taking place from region to region. First we meet the old dun horse, with its tendency to become white, the best European examples of which were probably the now extinct ponies of the Lofoden Isles. In Asia, Prejvalsky's horse is the best living instance—a dun-coloured animal with little trace of stripes. Bordering on the Prejvalsky horse or true tarpan come the Asiatic asses: first the dzeggetai of Mongolia, a fawn-coloured animal, the under-parts being Isabella-coloured; then comes the kiang of the Upper Indus valley, seldom found at a lower altitude than 10,000 feet, rufous-brown with white under-parts, whilst, as might be expected from its mountain habitat, its hind-quarters are much more developed in length and strength than in the asses of the plains. The *Onager indicus, onager* and *hemippus* are found in all the great plains of the Punjab, Afghanistan, Western India, Baluchistan, Persia, and Syria, whilst a few are said to survive in South Arabia. All these are lighter in colour than the kiang, the typical onager being a white animal with yellow blotches on the side, neck, and head. All the Asiatic asses are distinguished by the absence of any shoulder stripe, though they occasionally show traces of stripes on the lower parts of the legs. The southern Asiatic asses just described, in their greyer colour and smaller hoofs approximate to the wild asses of Africa, especially to those of Somaliland, whilst it is maintained that in their cry, as well as in their colour, the kiang and dzeggetai come closer to the horse, the next neighbours of which they are.

Passing to Africa, we find the ass of Nubia and Abyssinia showing a shoulder stripe, and frequently with very strongly defined narrow stripes on the legs, the ears being longer than those of the onager. But in closer proximity to South-Western Asia comes the Somali ass, which differs from those of Nubia and Abyssinia by being greyer in colour, by the entire absence of shoulder stripes, and by smaller ears, in all which characteristics it comes closer to its neighbours on the Asiatic side than it does to its relations in Abyssinia and Nubia.

Next we meet the zebras. First comes the magnificent Grévy zebra of Somaliland, Shoa, and British East Africa. It is completely striped down to its hoofs, but the coloration of the specimens from Shoa differs from that of those from Somaliland and from those of British East Africa. The Grévy zebra has its hoofs rounded in front like those of a horse, but its ears are more like its neighbours the asses than those of any other zebra.

In the region north of the river Tana the Burchelline group of zebras overlaps the Grévy, and though it differs essentially in form, habits, and shape of its hoofs from the Grévy, some of those in the neighbourhood of Lake Barringo show grid-iron markings on the croup like those on the Grévy zebra, whilst, like the latter, they also possess functional premolars.

All the zebras of the equatorial regions are striped to the hoofs, but when we reach the Transvaal, the Burchelline zebra, known as Chapman's, is divesting itself of stripes on its legs, whilst the ground colour is getting less white and the stripes less black. Further south the true Burchell zebra of the Orange River has completely lost the stripes on its legs and under-surface, its general colouring being a pale yellowish-brown, the stripes being dark brown or nearly black. South of the Orange River the now extinct quagga of Cape Colony had not only begun to lose the stripes of its under-part and on the hind-quarters, but in Daniell's specimen they only survived on the neck as far as the withers, the animal having its upper surface bay and a tail like that of a horse, whilst all specimens of quagga show a rounded hoof like that of a horse.

In the quagga of 30° to 32° S. we have practically a bay horse corresponding to the bay Libyan horse of lat. 30°–32° N.

But the production of such variations in colour does not require great differences in latitude. On the contrary, from a study of a series of skins of zebras shot for me in British East Africa, each of which is from a known locality and from a known altitude, there can be no doubt that such variations in colour are found from district to district within a comparatively small area.

In addition to the two species of zebra already mentioned, there is the mountain zebra, formerly extremely common in the mountainous parts of Cape Colony and Natal, though now nearly extinct in that area. Its hind legs, as might naturally have been expected from its habitat, are more developed than those of the other zebras, just as these same limbs are also more developed in the kiang of the Himalayas than in any other ass.

With these facts before us, there can be no doubt that environment is a most potent factor, not only in coloration, but also in osteology. No less certain is it that environment is capable of producing changes in animal types with great rapidity. Thus, although it is an historical fact that there were no horses in Java in 1346, and it is known that the ponies now there are descended from those brought in by the Arabs, yet within five centuries there has arisen a race of ponies (often striped) some of which are not more than two feet high. Darwin himself has given other examples of the rapid change in structure of horses when transferred from one environment to another, as, for instance, when Pampas horses are brought up into the Andes.

Another good example is that of the now familiar Basuto ponies. Up to 1846 the Basutos did not possess a single horse, those of them who went down and worked for the Boers of the Orange River usually taking their pay in cattle. At the date mentioned some of them began to take horses instead. These horses were of the ordinary mixed colonial kinds, and we may be sure that the Boers did not let the Basutos have picked specimens. The Basutos turned these horses out on their mountains, where, living under perfectly natural conditions, their posterity within less than forty years had settled down into a well-defined type of mountain pony.

Nor is it only in the horse family that we meet with examples of the force of environment. The tiger extends from the Indian Ocean, through China up to Corea, but the tiger of Corea is a very different animal from that of Bengal. Instead of the short hair of the Indian tiger, the Corean has clothed himself with a robe of dense long fur to withstand the rigours of the north. It is not unlikely that if we had a sufficient number of skins from known localities we could trace the change in the tiger from latitude to latitude, just as I have shown in the case of the Equidæ.

Now whilst there is certainly a general physical type common to all the peoples round the Mediterranean, it by no means follows that all those peoples are from the same original stock. On the contrary, the analogy from man in other parts of the world, as well as that of the Equidæ, suggest that the resemblance between the Berbers, who speak Hamitic, the Greeks who speak Aryan, and the Jews and Arabs who spoke Semitic, is simply due to the fact that those peoples, from having long dwelt under practically similar conditions in the Mediterranean basin, have gradually acquired that physical similarity which has led Sergi to the assumption that they have a proximate common ancestry, and that they accordingly form but a single race.

Nor is there any lack of instances of convergence of type under similar conditions in the case of the lower animals. We saw that the asses of South-Western Asia approximate in colour to the asses of North-East Africa, and in respect of the size of the ears and absence of shoulder-stripe, more especially to the nearest of these, the ass of Somaliland. Yet it does not follow that they are more closely related to the Somali ass than they are to their own next neighbours, the kiang. On the contrary, it is much more likely that the Somali ass is closely related to those of Abyssinia, and that the South-Western Asiatic asses are closely related to the kiang. The approximation in colour, absence of shoulder-stripe, and size of the ears between the asses of Somaliland and those of South-Western Asia must rather be explained by a convergence of types under the somewhat similar climatic conditions of Somaliland and the nearest parts of South-Western Asia. Again, though there are very strong specific differences between the Grévy and Burchelline zebras met in the neighbourhood of Lake Barringo, there is a curious approximation not only in marking but also in the teeth between these two species, which is best accounted for by supposing that it is the outcome of similar environment. It may be said that this approximation may be due to the interbreeding of the two species of zebras in the region where they overlap. This, in itself a most unlikely contingency from all that is known of the habits of wild species, certainly cannot be alleged in the case of the convergence in type between the asses of South-Western Asia and the Somali ass, since they are separated by the Red Sea and the Persian Gulf.

Again, the representative of the crocodile family in the Ganges is distinguished by the extreme elongation of the head and jaws, whilst the same elongation of the head is equally characteristic of the representative of the dolphin family found in the same waters. Again, all through the Indian Ocean wherever any family of crabs have become inhabitants of coralline sands its members have long legs. Again, it has long been noticed that in Cutch all the larger animals have a tendency to become a sandy colour, whilst in certain areas of South America insects, no matter to what family they belong, have a tendency to one common aspect.

It may of course be said that the changes in colour of the horse family, tigers, and insects are for "protective" reasons. But the case of the horse family alone is sufficient to dispose of this objection. The kiang of the Himalaya had no dangerous enemy until man was armed with a rifle. In Africa the zebras have had only two formidable foes—man and the lion. It is asserted by the most experienced hunters that the gaudy livery of the zebra makes him conspicuous from afar, whether he is on the mountain, on the plain, or in the shade of a tree. His brilliant colour therefore really exposes him to man. But it will be said that it is well adapted to conceal him at night, at which time the lion seeks his prey. Yet as the best authorities hold that the lion hunts entirely by scent, the coloration of the zebra affords him no protection against his inveterate foe.

I have shown that in horses the colours—such as bay, black, grey, and white—accompany certain well-defined inward qualities. But as black is most certainly not a primitive horse colour, it follows that coat colours may be intimately connected with certain other characteristics quite irrespective of protective colouring. Again, as the variation in the size and shape of the ears and hoofs of the asses and zebras cannot be set down to protective colouring, but must be due to other causes, there is no reason why variations in colour should not be ascribed to similar causes.

The argument based on the analogy of the horse family and the tigers, and on that of the natives of the New World, may be applied to the races of Africa. Next to the Mediterranean lie the Berbers and their Hamitic congeners, who are regarded as part of the Eurafrican species by Sergi and his school. But the Berbers are not all of the typical Mediterranean physique. The blonde Berbers of the highlands of Rif in North-West Morocco and of the Atlas have long been well known. In the region lower down and in Western Tunis the occurrence of the xanthochrous type seems much less frequent, whilst further east it practically disappears.

It is certain that there was a fair-haired element in Libya long before Rome conquered Carthage or the Vandals had passed into the ken of history. Callimachus testifies to the existence of blonde Berbers in the third century B.C. We may hold, then, with Sergi and others that the blonde element in the Berbers is not a survival from invasions of Vandals or Goths, or from Roman colonists, but that they rather owe their fair complexions and light-coloured eyes to the circumstance that they were cradled in a cool, mountainous region, and not along the low-lying border of the Mediterranean like their dark-coloured relations whose language and customs they share.

If, then, some of those who speak Hamitic are fair, and have been fair for centuries before Christ, as Sergi himself admits, whilst others are dark, there is no reason why some of the peoples who speak Aryan might not be dark whilst others are blonde.

The Berbers and their Hamitic congeners shade off on the south into other peoples, but this is not altogether due to intermarriage, as is commonly held, for it is more probably to be explained as due in a large part to climatic conditions. The Bantus, who are said to have originated in the Galla country and to have spread thence, are now regarded by the chief authorities as the result of an intermixture of Hamites and Negroes. But, on the grounds I have already stated, it is more rational to regard them as having been evolved in the area lying between the Hamitic peoples on the north and the Negroes on the south, just as we have corresponding types of the horse family in Nubia and Abyssinia and in the equatorial regions. The same hypothesis also explains the existence of those cattle-keeping tribes which lie west of the Nile stretching across Northern Nigeria, who border on the Berbers, but yet differ from them, and border also on the Negroes, but differ from them likewise. South of these tribes come the Negroes, the true children of the equator. The Bantu is able to live in elevated equatorial areas, and he has burst his way down to the subtropical and temperate parts of South Africa, where he especially flourishes in the highlands, thus showing that his race was originally evolved under similar conditions. The Bantu found in the South the Hottentots, who are especially distinguished by steatopygy, a feature which has led some to identify them with the primitive steatopygous race supposed to have once lived in Southern Europe, Malta, and North Africa, and to have left evidence of their characteristic in their representations of themselves. But, granting that such a race once lived in North Africa and Southern Europe, there is really no more reason for supposing that they and the Hottentots formed one and the same race than there is for assuming that Daniell's quagga, which was practically a bay horse, was proximately akin to the bay horse of North Africa. The occurrence of steatopygy in two areas so wide apart is not due to an ethnical migration, but rather to similar climatic conditions producing similar characteristics.

As some anthropologists so commonly explain the origin of races such as the Bantus by intermarriage, it may be well to see whether intermarriage between two races, one of which is an invader, is likely to produce a permanent effect upon the general physique of a whole community. I have shown elsewhere that the many invasions of fair-haired races into the three southern peninsulas of Europe and into the Ægean islands have left no permanent trace on the population. It is a matter of common knowledge that the offspring of British and native parents in India have a constant tendency to die out. The same undoubtedly holds true for the offspring of British soldiers serving in Egypt, the Soudan, and West Africa. The native race always reasserts itself. In America the Spanish blood has died out, or is dying out, everywhere except in the temperate regions of Chile, Quito, and Argentina, where the descendants of the Spanish settlers thrive in a climate very analogous to that of Spain. In the Southern States of North America the whites cannot flourish, and only just manage to survive. On the other hand, the descendants of the Negro slaves imported into Brazil, the West Indies, and the Southern States of North America thrive and multiply with extraordinary vigour, a fact doubtless due to their race having been evolved under similar conditions in equatorial Africa.

Even from the evidence already to hand there is high probability that intermarriage can do little to form a new race unless the parents on both sides are of races evolved in similar environments.

I have already pointed out that although the fair-haired race of Upper Europe has age after age kept pouring over the Alps into Italy and the other southern peninsulas, and have constantly intermixed with the indigenous populations, it is only in the upper part of Italy that the blonde race is able to hold its own. In Italy the xanthochrous race in ancient times, as to-day, had its maximum along the Alps, and gradually dwindled towards the south until the melanochrous race stood practically alone in the lower part of the peninsula. So too in the Balkan, whilst the fair-haired element was at its maximum along the Alps and the Danube, southwards the melanochrous becomes more and more completely dominant, as it practically is to-day in the lower part of the peninsula.

(b) In the Alpine regions there has been from Neolithic times a brachycephalic race, also found in Central France and in the British Isles, whither it is supposed to have come in the Bronze age. It has been a fundamental article of faith with Sergi and others that this round-headed race came from Asia, the home of brachycephalism. It is Mongolian according to most, and spoke a non-Aryan language; but Sergi regards it as Aryan, thus reverting to the old doctrine, which made the Aryans come from Central Asia, and he assumes that these invaders imposed their language both on the aborigines of Italy, such as the Ligurians, and on the blonde race of Northern Europe; but we shall soon see that this assumption has no base. Now, as these folk dwelt in the region where we find the Ligurians of historical times, others have argued that the Ligurians were a non-Aryan people from Asia. But it is impossible to find any hard-and-fast lines between the Alpine race and the peoples north and south of it in culture and sociology. For that reason when treating of the people of the Alps in my "Early Age of Greece" I did not take any account of the difference in cranial measurements. In 1906, at the British Association, I maintained that this difference of skull type did not mean any racial difference, and on the analogy of the changes in the osteology of the Equidæ I urged that the roundness of the skulls was simply due to environment, as the horses of the Pampas when brought up into the mountainous regions of Chile and Peru rapidly change their physical type. Physical anthropologists have already maintained that the round head of the Mongolian has been developed in the high altitude of the Altai. If that be so, there is no reason why a similar phenomenon should not have taken place in the Alpine region, in Albania, Anatolia, and wherever else in mountain areas brachycephaly has been found in more than sporadic examples, which of course may well be due to migrations or importation of slaves. But I am far from suggesting that altitude is the only cause of brachycephaly.

The evidence then, so far as it goes, points to the same conclusion as that to which we came as regards pigmentation, and it may eventually be proved that just as each area has its own type of coloration, so also has it its own osteological character. In support of this I may point out that recently Dr. William Wright, Hunterian lecturer, has come to the conclusion from his craniological investigations that the brachycephalic Alpine race was evolved on European soil, whilst Dr. C. S. Myers has been led by his researches on Egyptian skulls to conclude that, "in spite of the various infiltrations of foreign blood in the past, modern Egypt contains a homogeneous population which gradually shifts its average character as we proceed southwards from the shores of the Mediterranean to Nubia beyond the First Cataract."

It is not impossible that Alpine environment may have acted upon the shape of the skull of the ox as well as that of man. We know from the examination of the fauna of the Lake dwellings of Switzerland that the Celtic ox (*Bos longifrons*) was there the common type, and its descendants still continue to be the typical breed along the Alpine chain. This ox is characterised by its strongly developed occipital region and its small horns curved forward and inward. As it differs so essentially from the urus (*Bos primigenius*) and from the long-horned cattle of the Mediterranean lands, it seems not unlikely that the peculiar cranial formation may have been evolved under mountainous environment.

It is now clear that differences in the shape of the skull and in the colour of the skin, hair, and eyes cannot be at all implicitly relied on as criteria of race. The defenders of the non-Aryan character of the dark races of Greece, Italy, Spain, France, and the British Isles have now to depend on two arguments only, one of which is linguistic, the other sociological. It is admitted that it is very difficult to point to any non-Aryan survivals in the vocabularies of the languages of these countries, and it is also admitted that in them all the tense system of the Aryans has been taken over in its entirety. Neither Kretschmer nor anyone else has ventured to affirm that there is any survival of non-Aryan syntactical forms in Greek, the language of all others in which the Aryan tense system is found in its greatest delicacy and perfection. But we know that in all cases where an Aryan language has without doubt been adopted by a non-Aryan folk the tense system is invariably broken up. No better example than this is needed than ordinary "pigeon" English. So difficult is it for the defenders of the non-Aryan theory of the origin of the aborigines of Greece to maintain their position that one of the latest, Prof. Burrows, has to rely on certain supposed syntactical survivals of a non-Aryan language which Sir John Rhys believes that he has found in Welsh and Irish and in the remarkable resemblance which Prof. Morris Jones thinks that he has traced between the syntax of those languages and that of Berber and ancient Egyptian.

Yet when we examine the evidence on which Sir John Rhys relies, it turns out to be only three Welsh and Cornish oghams, written not in pure Celtic, but in dog Latin, and also two Irish oghams, which show a looseness in the use of the genitive suffix at a time when final syllables were dropping out of use in Irish. Sir John Rhys supposes that the non-Aryan inhabitants of these islands derived their Gaelic speech from a people whom he terms Celticans, who spoke Goidelic, and who were followed by the Brythons, who found the aborigines already Celticised. Prof. Morris Jones freely admits that the aborigines must have borrowed the full Aryan tense system, a fact in itself sufficient, from what I have already said, to arouse grave suspicions as to the validity of any arguments based on supposed fundamental grammatical differences. But this supposed taking over of the full Aryan tense system by the non-Aryan aborigines of these islands is rendered all the more miraculous from the circumstance that Sir John Rhys holds that his Celticans who spoke Goidelic "came over not later than the great movements which took place in the Celtic world of the Continent in the sixth and fifth centuries before our era," that the Brythons came over to Britain between the time of Pytheas and that of Julius Cæsar," and that the Brythons were not likely to come into contact on any large scale with the aborigines "before they had been to a considerable extent Celticised." It is thus assumed that it was possible for the aborigines to have been so completely Celticised as to have adopted the Aryan tense system, as well as the Aryan vocabulary, in its fulness in the interval between the sixth or fifth century and the second century B.C. Yet English has been the master speech in Britain for many centuries, and that, too, when reading and writing have been commonly practised; yet Gaelic still survives, whilst Welsh not only survives, but flourishes. It is therefore simply incredible that such a complete transformation as that postulated could have taken place in three or four centuries in an age when writing and literature can be hardly said to have existed in these islands.

Let us now see under what conditions does one race or people borrow the language of another. Slaves of course take over the language of their masters, but we have to consider (1) the adoption by a conquering people of the language of the conquered; (2) the adoption by a conquered people of that of their conquerors; and (3) the adoption by a people, themselves unconquered, of the language of their neighbours. Under what conditions do the conquerors adopt the language of the conquered? Ireland affords us at least two certain examples. Cromwell planted large bodies of his English soldiers in Tipperary, but they had no English women, and therefore took as wives the daughters of the land, who spoke the Irish language. From this union resulted a splendid offspring, who spoke chiefly the language of their Irish mothers, and not their fathers' English. So it came to pass that in a single generation the progeny of Cromwell's Puritans were in language as Irish as the purest-blooded aboriginal of Munster. Yet this adoption of the Irish language by the great majority of the children of these settlers took place in spite of the effect which the reading of books in English must have exerted to counteract the tendency to adopt the Irish language. Let us go back five hundred years in Irish history, and we find exactly the same process going on. The Normans who followed Strongbow into Ireland, like their captain, frequently married native women. It is a matter of common knowledge that the Anglo-Norman settlers in a short time became *Hiberniores ipsis Hibernis*.

These and other examples too numerous to cite here prove that the children of bodies of conquerors who marry the women of the land will have an inevitable tendency to follow their mothers' speech. We may also lay down as a solid factor in the tendency of the conqueror to merge into the conquered the isolation of the conquerors from their original homes and from the great mass of those who speak the same language.

Next we come to the case where the conquerors bring with them some women of their own race. This of course helps to keep their own language alive, as a certain number of the children speak it as their mothers' tongue. But even in these circumstances the invaders are liable to drop their own language and practically adopt that of the natives. Thus the Northmen who settled on the coast of France gradually abandoned their national tongue for French, though modifying dialectically their adopted language. When under the name of Normans they conquered and settled in England, they again adopted the language of the conquered, though modifying the English tongue by many words and phrases brought with them from Normandy, and we have just seen how some of their descendants who settled in Ireland for the third time changed their speech for that of the conquered.

Hitherto all our examples show the adoption by the conquerors of the language of the conquered, even when they bring a certain number of their women with them.

We now come to undoubted cases where the language of the conqueror has been able to get a firm foothold. From the time of the plantation of Ulster, the advance of the English tongue, and consequent decadence of the Irish, has steadily proceeded, for the settlers, unlike Cromwell's Ironsides, brought with them women of their own race and speech. Consequently their children grew up speaking English as their mothers' tongue. Yet even with such a basis the advance of English amongst the Irish has been exceedingly slow. In the glens of Antrim the Irish language still lingers on, whilst in Donegal, Connaught, Kerry, Cork, and Waterford, English has not succeeded in ousting completely the native language, though the former is the language of the national schools, of the newspapers, and of trade.

The story of the establishment of English itself in Britain is just the same as in Ulster. We know from Bede that the Angles who settled in Britain left Holstein in large bodies, bringing with them their wives and families, and leaving their old homes without inhabitant. Having thus settled in solid masses in the east of Britain, they retained fully their own tongue, impressed it upon their menials, and gradually, as they extended their conquests westward over the island, English became the language of the land. Yet in Wales the ancient speech still flourishes.

We may therefore conclude that the adoption by the conquered of the language of the conqueror, even when it does take place, which is but rarely, is a very slow and tedious process, although every advantage is on the side of the invading tongue, and that when the native speech gets a fair field, as in Wales, the language of the conqueror can make little or no advance.

Only the third possibility now is left—that one people can adopt without conquest the language of another. But no example of such can anywhere be found, although Europe presents numerous instances to the contrary. There can be no stronger case than that of the Swiss Republic, in which peoples with more than four kinds of language combine for national defence and other advantages. Here, if anywhere, we ought to find a gradual adoption by certain cantons of the language of their neighbours. But, far from this being so, the German, French, Roumansch, and Italian cantons rigidly preserve their respective mother-speeches. In the Austro-Hungarian Empire there is no tendency observable on the part of either Magyars or Slavs to adopt German; nay, the very opposite is the case. Again, the Finns have not adopted either Swedish or Russian, though partitioned between their more powerful neighbours.

To sum up, it seems that no nation readily adopts the language of another, even though it be in close ties of friendship; whilst there is still less tendency when national hostility intervenes. Secondly, the adoption of the language of the conqueror by the conquered, except in the most favourable circumstances, is not common, and only takes place by a very gradual process, as is seen in the case of Ireland. Thirdly, there is a strong tendency for the conqueror to adopt the language of the conquered, as was done by the Normans in England, in Ireland, in Sicily, and in Italy; by the Cromwellian settlers in Tipperary, by the Bulgari in Bulgaria, by the Franks in Gaul, by the Lombards in Italy, and by the Visigoths in Spain. There is thus an inevitable tendency for the children to speak their mothers' tongue, and indeed the phrase "mother-tongue" is based on the fact, observed through long ages, that the child learns its first words from its mother, and thus takes after her in speech. This law, which still holds good in modern days and in civilised communities, must have been far stronger in earlier times in countries where the tie of marriage hardly existed and the child belonged to its mother's and not to its father's tribe, as is still the case in many parts of the world.

In view of these facts we cannot accept Sir John Rhys's hypothesis that when a few bodies of invaders, whom he terms Celticans, passed into Ireland the indigenous supposed non-Aryan race within two centuries completely abandoned its own language, taking over in its entirety the Aryan tense system as well as the Aryan vocabulary of its conquerors.

Now let us turn to Greece, Italy, and Spain. It is admitted that neither Arcadia nor Attica was ever conquered by Acheans or Dorians, yet in both these areas the Greek language existed through all historical time, and in Attica especially the Aryan tense system is found in its highest perfection. The dialect of Arcadia cannot have been taken over from Acheans or Dorians, because it is the same as that of the Cypriotes from Arcadia who settled in Cyprus at least 1100 B.C. It is also very close to the dialect of Pelasgiotis in Thessaly, the home of the aboriginal Pelasgian population, whilst it comes closest of all Greek dialects to that of the ancient Epic. There can therefore be no doubt that Arcadian is no mere bastard lingo, half non-Aryan, half Aryan, but is the genuine speech of the oldest and most unmixed population of Greece, who were undoubtedly a melanochrous race, and who also most certainly had occupied Greece from the Stone age.

The Ligurians, who formed from the Stone age the bottom stratum in all Upper and Central Italy, are now admitted to have spoken an Aryan language, and I have recently given some reasons for believing that the Latin language is simply the native tongue of the aboriginal Ligurian population of Latium with some admixtures derived from the Italic tribes of Siculi and Sabines. I have also shown that the ancient Iberians, the next neighbours of the Ligurians, used the same forms of place-names as the latter, and that some of the words plainly exhibit Aryan terminations. Thus we may conclude that with the exception of the Basques, who are probably a non-Aryan spurt from North Africa, the melanochrous populations of Spain, Italy, the Balkan Peninsula, France, Britain, Ireland, and Holland have from the first spoken none but an Aryan language.

(*c*) Only one argument is now left to the defenders of the non-Aryan theory. When the study of sociology first sprang up in the last century, it at once became a fundamental doctrine that the Aryans had always been strictly patriarchal, and that polyandry and descent through women was unknown amongst them. Though this view has received many rude shocks in later days, Prof. Zimmer argues from it that the indigenous people of Britain and Ireland were non-Aryan.

It is well known from the ancient writers that the Picts were polyandrous, and that succession was consequently through females. Again, it is certain, both from the ancient Irish literature and also from statements of external writers, that the Irish were polyandrous, and that they also almost certainly traced descent through women. Accordingly Prof. Zimmer infers that the indigenous race was non-Aryan. But McLennan has long since pointed out that descent through women was the ancient law at Athens, and I have just shown that the Athenians and Arcadians, the autochthonous, dark-complexioned people of Greece, never spoke any save an Aryan tongue. Moreover, I have shown elsewhere that the Ligurians, who are now generally admitted to have spoken always an Aryan language, had descent through women, whilst I have also pointed out that there is good evidence that the ancient Latins, who have generally been taken as typical Aryans, had the same system. Again, it is admitted that the ancient Illyrians and dark-complexioned Thracians spoke an Aryan language, which, inasmuch as it differed materially in certain ways from that spoken by their Celtic overlords, must have been aboriginal, whilst I have further given grounds for believing that the ancient Iberians (though not the Basques) were also an Aryan-speaking folk. But there is good evidence that the Illyrians, melanochrous Thracians and Iberians all traced descent through women. In view of these facts it is useless to urge that because the Picts of Scotland and the ancient Irish had that system of succession through females these peoples must have been non-Aryan.

We have now reviewed the three main criteria of race at present used by anthropologists: (*a*) pigmentation of the skin, hair, and eyes; (*b*) the shape of the skull and other osteological characteristics; and finally (*c*) their system of tracing descent. We have seen that osteological differences may be but foundations of sand, because it is certain that such variations take place within very short periods, not only in the case of the lower animals, as in the horse family, but in man himself. Pigmentation is no true criterion, for we have found a steady tendency to change in colour in the case of the lower animals from latitude to latitude, whilst in the case of man the steady shading off in colour from dark to blonde may be traced from the equator to the Baltic. Unless then we postulate that man is entirely free from the natural laws which condition the osteology and pigmentation of other animals, we must admit that neither bone nor colour differences can be regarded as crucial criteria. Further, we saw that the test of descent through males or females broke down absolutely in the case of peoples who can be proved historically never to have spoken any but a non-Aryan language. Finally, we are forced to the conclusion that language, now that we realise what are the laws which govern its borrowing by one race from another, is really the surest of all the known tests of race when dealt with broadly and over wide areas, and not merely in the way of guesswork etymologies.

II. Hitherto I have dealt only with the need of a rigid application of zoological laws in studying the evolution of the various races of man. In the time that is still left I propose to touch briefly on the vast importance of such natural laws when dealing with the native races of our great dependencies and colonies, and in our own social legislation. I venture to think that the gravest mistakes which at present are being made in our administration and legislation are due to the total disregard of the natural laws, which not only modify and differentiate one race from another, but also are constantly producing variations within our own community. As physical characteristics are in the main the result of environment, social institutions and religious ideas are no less the product of that environment. Several of our most distinguished Indian and Colonial administrators have pointed out that most of the mistakes made by British officials are due to their ignorance of the habits and customs of the natives. It has been in the past an axiom of British politicians that in the English Constitution and in English law there is a panacea for every political and social difficulty in any race under the sun. Only let us give, it is urged, this or that State a representative parliamentary system and trial by jury and all will go well. The fundamental error in this doctrine is the assumption that a political and legal system evolved during many centuries amongst a people of North-Western Europe, largely Teutonic, and that too living not on the mainland but on an island, can be applied cut and dried to a people evolved during countless generations in tropical or subtropical regions, with social institutions and religious ideas widely different from those of even South Europeans, and still more so from those of Northern Europe. We might just as well ask the Ethiopian to change his skin as to change radically his social and religious ideas. It has been shown by experience that Christianity can make but little headway amongst many peoples in Africa or Asia, where, on the other hand, Mohammedanism has made and is steadily making progress, acting distinctly for good, as in Africa, by putting down human sacrifice and replacing fetish worship by a lofty monotheism. This is probably due to the fact that Mohammedanism is a religion evolved amongst a Semitic people who live in latitudes bordering on the aboriginal races of Africa and Asia, and that it is far more akin in its social ideas to those of the Negro or Malay than are those of Christianity, more especially of that form of Christianity evolved during the last twelve centuries by the Teutonic peoples of Upper Europe, who are of all races furthest in physical characteristics, in religious ideals and social institutions, from the dark races of Africa and Asia. This great gulf is due not merely to shallow prejudice against other people's notions, it is as deep-seated as is the physical antipathy felt by the Teuton for the Negro, which is itself due to the very different climatic conditions under which both races have been evolved. The Teuton does not freely blend with the black, and even when he does intermarry he treats his own half-bred progeny with contempt, or at most with toleration. On the other hand, some South Europeans, for example the Portuguese, are said to have little objection to intermarrying with dark races and allowing the mixed progeny an equal social status, whilst the Arab through the ages has freely taken to wife the African, and has never hesitated to treat the hybrid offspring as equals. There is thus a wide breach between the physique and the social and religious ideas of the African and our own; but, as political and legal institutions are indissolubly bound up with social and religious, it follows inevitably that the political and legal institutions of a race cradled in Northern Europe are exceedingly ill adapted for the children of the equator. Accordingly in any wise administration of these regions it must be a primary object to study the native institutions, to modify and elevate them whenever it may be possible, but never to seek to eradicate and supplant them. Any attempt to do so will be but vain, for these institutions are as much part of the land as are its climate, its soil, its fauna, and its flora. "Naturam expellas furca, tamen usque recurret." Let us hope for a successful issue for the effort now being made by the Royal Anthropological Institute to establish an Imperial Bureau of Anthropology the function of which will be, not only to carry out systematically the scientific study of man, but also to aid the administrator and the legislator, the merchant and the missionary.

III. I now pass to my last and most important topic—natural laws in relation to our own social legislation. We have seen that environment is a powerful factor in the differentiation of the various races of man, alike in physique, institutions, and religion. It is probable that the food-supply at hand in each region may be an important element in these variations, whilst the nature of the food and drink preferred there may itself be due in no small degree to climatic conditions. Each zone has its own peculiar products, and beyond doubt the natives of each region differ in their tastes for food and drink. The aboriginal of the tropics is distinctly a vegetarian, whilst the Eskimo within the Arctic circle is practically wholly carnivorous. In each case the taste is almost certainly due to the necessities of their environment, for the man in the Arctic regions could not survive without an abundance of animal fat. It is probable that the more northward man advanced the more carnivorous he became in order to support the rigours of the northern climate. The same holds equally true in the case of drink. Temperance reformers would enforce by legislation complete abstinence from all alcoholic liquors, and they point to the sobriety of the Spaniards, Italians, and other South Europeans, and urge, if these nations are so temperate, why should Britons and Irish continue to drink beer and spirits in such large quantities? This appeal depends unfortunately on the false assumption that the natives of these islands enjoy the same climate as the people of the sunny south. All across Northern Europe and Asia there is a universal love of strong drink, which is not the mere outcome of vicious desires, but of climatic law. In Shakespeare's time "your Englishman was most potent in potting," and this was no new outbreak of depravity, for the earliest reference in history to the natives of these islands tells us the same tale. When Pytheas of Marseilles travelled in these regions, about 350 B.C., he found the people making "wine from barley," and, though he does not explicitly say so, we need not doubt that it was meant for home consumption. In view of these facts we must regard this tendency as essentially climatic. This view derives additional support from the well-authenticated fact that one of the chief characteristics of the descendants of British settlers in Australia is their strong teetotalism. This cannot be set down to their having a higher moral standard than their ancestors, but rather, as in the case of Spaniards and Italians, to the circumstance that they live in a country much warmer and drier than the British Isles. We must therefore, no matter how reluctantly, come to the conclusion that no attempt to eradicate this tendency to alcohol in these latitudes can be successful, for the most that can be done by the philanthropist and the legislator is to modify and control it, but especially by moral means.

I have spoken of the principles at work in the differentiation of one race from another. It may be that the same principles or others closely allied may be at work within each community, for each community is but the whole world writ small. Within the United Kingdom itself there are not only different physical types, but very different ideas respecting marriage and divorce embodied in the laws regulating those fundamental institutions in England, Scotland, and Ireland. If such fundamental differences exist in that most important of social institutions, we may well expect that the natural laws which differentiate one race from another may be at work within every community in the United Kingdom.

Yet though the world has been ringing with the doctrine of natural selection and the survival of the fittest for nearly half a century, no statesman ever dreams of taking these great principles into consideration when devising any scheme of education or social reform. On the contrary, it is a fundamental assumption in all our educational and social reforms that all men are born with equal capacities; that there is no difference in this respect between the average child of the labourer, sprung from many generations of labourers, and one born of many generations of middle or upper-class progenitors; and it is held that all that is necessary to make the children of the working classes equal, if not superior, to the children of the bourgeois is the same food, the same clothing, and the same educational advantages On that account we have devised the so-called educational ladder. Yet if we ask any social reformer why are there middle classes, the answer will probably be that they are better off. But why are they better off? We are told that their fathers and mothers were better off, and that they thus got a better chance than the poor labourer. But why were the parents of these middle-class folks better off? Oh! they came of families that had been long well-to-do. But why were these families long well-to-do? At last we are brought to the conclusion of the northern farmer, that "Work mun 'a gone to the gittin' whiniver munny was got." and to his brutal correlative respecting the labourers that "Them or thir feythers, tha sees, mun 'a beän a laäzy lot."

Work no doubt has been a main factor in the evolution of the middle and upper classes, especially in later times, though undoubtedly other qualities, such as superior physique and superior courage, have been very important elements in the earlier stages. But at all times it is not improbable that the special quality which led to their rise was a superior self-restraint, that enabled them to resist the vices which are too often attendant on prosperity. This superior morale acts in turn upon the offspring by setting up a better standard of life in the home, which of itself gives children brought up in such an environment an advantage at the outset of life denied to the children of inferior parents. It needs no elaborate induction to prove that the middle classes are not the outcome of chance, but of a long process of natural selection and the survival of the fittest in the struggle for life, the two main factors in this evolution being, in the language of Aristotle, heredity and training. Each community is but a microcosm of the whole human race, which, as I have endeavoured to show, is bound by the same laws as the rest of the animal kingdom. One race becomes a master because of its superior physique, courage, brain power, and morale; another sinks in the struggle or lags behind owing to its inferiority in the very qualities which have given the mastery to its rival. What is true of master races in relation to inferior races is equally true of the individuals in each community. The middle and upper classes are in the main sprung from ancestors with better physique, courage, and morale, and who have generation after generation been brought up in a better moral atmosphere than the children of the masses. Their ranks are also continually being reinforced by the best of the working classes. But this is not due to any educational ladder provided in modern times, for the process has always been at work, though of course its action has been distinctly aided by modern legislation. Mediæval history supplies many examples of those who, though sprung from the humblest parents, rose to high place in Church and State. This was not due to any legislative enactments, but rather to a principle well known in the whole field of Nature. Everyone knows that the superior varieties of flowers and vegetables are commonly the "sports," as they are termed, from inferior species. The skilful gardener watches carefully for good "sports," for they may become very valuable additions to his *répertoire* of useful plants. So, too, the legislator must watch carefully for good human "sports," not for those with criminal propensities. In the mediæval world the Church provided a ladder by which the son of the peasant could rise to be the counsellor of kings and princes. In modern times the State provides an educational ladder by which the child of the humblest parents may rise, if it has the capacity, to the highest positions in the community. It is right—nay, essential—that such a ladder should be provided, but this ladder is not for the mass of children. The vast majority can never climb beyond its lowest rung owing to their heredity, and in a less degree to their home environment. The ladder is for the good "sports," who by its aid are thus continually reinforcing with fresh blood the ranks of the middle and upper classes.

It may be said that I underrate the number of the good "sports." Of course it is very difficult to get any exact statistics on so complex a subject; but according to information which I have obtained from one of our great industrial centres, where the educational ladder enables any child who passes the fourth standard in the primary schools before it is eleven to rise into the secondary schools, it is probable that no more than 5 or 6 per cent. of the children of the working classes have at the age of sixteen the same amount of brain power as the average children of the middle classes at the same age. But even all this 5 or 6 per cent. of "sports" cannot be credited to parents of the working class alone, for it may be that a certain proportion of them must be ascribed to middle- or upper-class parents. Of course these rude statistics must be corrected by others collected on a large scale all over the country before we can form a final judgment; but I believe that the evidence already to hand makes it improbable that more than a very limited percentage of the children of the working classes have the same ability as the average child of the middle classes.

In ancient days the chief end of the legislator was to produce a stalwart brood of citizens capable of bearing arms in defence of their country and advancing her material prosperity. Still more ought this to be the aim of our legislators to-day, for under modern conditions great masses of population are huddled together in a manner hardly known to ancient cities. To accomplish this great end, the legislator must not merely look to improved housing of the poor and the development of the physique of city populations. He must, so far as possible, conform to the principles of the stockbreeder, whose object is to rear the finest horses, cattle, or sheep. Amongst wild animals Nature selects the fittest for continuing the race, and the wise breeder simply aids Nature by selecting still more carefully the best animals. The legislator, on his part, ought similarly to foster the increase of the best element in the State, and on the other hand discourage the multiplication of the worst. Yet in our community statesmen of both parties have adopted the very opposite policy. The children of the working classes are educated at the cost of the State, the offspring of the wastrels are given free meals, and already there are demands that they shall be clothed at the expense of the ratepayers, and that the parents shall even be paid for providing them with lodging. It is not impossible that before long these demands will be conceded by either party in the State. The heavy additional expense incurred in this policy falls upon the middle-class ratepayers and taxpayers, who have to feed, educate, and clothe their own children at their own expense. It may be said that they can get free education for their children by sending them to the State schools; but this is to level down instead of to level up; for if they do so, they will be lowering the general morale of their own class, the most priceless asset of the nation. The heavy burden of taxation entailed by this policy, falling as it does with special weight on the middle classes, renders it more difficult each year for the young men and the young women in that class to marry before thirty, for they naturally shrink from the expense of bringing up large or even moderate-sized families. We need not then wonder at the falling-off in the rate of increase of the middle classes. Our legislators are bad stockmasters, for they are selecting to continue the race the most unfit physically and morally, whilst they discourage more and more the increase of what we have proved to be the outcome of a long process of natural selection. The present policy therefore tends to reduce that which in all ages has been the mainstay of every State, the middle class. The yeomen of England, the free burghers of Germany and of Italy, formed the best element in the Middle Ages. So was it also with the great republics of the ancient world. Aristotle, in more than one passage, has pointed out that the middle class, that which stands between the "excessively wealthy" and the "very poor," between the "millionaire" and the "wastrel," are the mainstay of every State, and he shows that, where the middle class has been crushed out by the millionaire or the mob, ruin has inevitably overtaken the State. Indeed, it is clear that the chief defect in the Greek democracies was the smallness and weakness of the middle class, whilst it is notorious that Rome prospered only so long as the middle-class citizens flourished. Her downfall came when they were extinguished by the great capitalists, who made common cause with the masses against them. The latter had no patriotism, were incapable of bearing arms, and had no aspirations beyond free meals and popular entertainments at the expense of the State.

It is of great scientific interest to discover how the short-skulled peoples of Asia and Europe became differentiated from their long-skulled congeners; it is of great practical importance to apply to the administration of our great dependencies and colonies the lessons taught by anthropology; but it is infinitely more important to maintain a vigorous stock of citizens for the kingdom and the empire. Questions of the origin of races are, after all, only academic; but the other two, more especially the last, are intimately bound up with the life of the nation. If the present policy of our legislators is adhered to, the moral and the physical standard of the British citizen will steadily deteriorate, for the population will gradually come to consist of the posterity of those who are themselves sprung from many generations of the most unfit. Should this unfortunately come to pass, it will be the result of human pride refusing to apply to the human race the laws which inexorably regulate all Nature.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ST. ANDREWS.—Dr. Hugh Marshall has been appointed successor to Prof. James Walker, F.R.S., in the chair of chemistry in University College, Dundee, and Dr. Percy J. Herring has been appointed to the Chandos chair of physiology in the United College, St. Andrews, in the room of the late Prof. Pettigrew, F.R.S.

MR. T. J. REES has been appointed superintendent of education for the borough of Swansea.

THE directorship of the research hospital of the Rockefeller Institute of New York City has been accepted by Prof. Rufus I. Cole, of the Johns Hopkins University.

MR. J. A. GILRUTH, chief veterinarian and Government bacteriologist of New Zealand, has been appointed director of the National Veterinary College and Research Institute now being established by the Government of Victoria, Australia.

A COURSE of public lectures on hygiene and public health has been arranged (in cooperation with the State Department of Health) for delivery at Cornell University. The introductory lecture will be given on October 8 by President Schurman.

THE *Times* reports that Prof. Borgman has resigned the rectorship of St. Petersburg University as a protest against the policy of the Minister of Education; it also says that the Council of Ministers has empowered the Minister of Public Instruction to forbid women to attend university lectures in future, but to permit those to complete their studies at universities who have already received permission, and whose transfer to higher educational institutions for women is impossible.

THE Royal Agricultural College, Cirencester, after an existence of sixty-three years, has been re-organised, that its sphere of activity and usefulness may be greatly widened, and that it may no longer be handicapped by non-eligibility to receive grants from public monies. Taking advantage of the enlarged powers now conferred upon it, the college proposes to advance the cause of agriculture in general, and the agricultural interests of the west of England in particular, by actively engaging in the following kinds of work:—(1) scientific research in agricultural subjects; (2) cooperation with the University of Bristol (by which it will, no doubt, be fully recognised) in the establishment of degree courses and degrees in agriculture and forestry; (3) continuance of the important work of training landowners, estate agents, and colonists; (4) training county scholars in agriculture; (5) continuing and extending the system of short courses for sons of tenant farmers; (6) establishing classes in subjects of rural education for the benefit of teachers; (7) cooperation with county councils in their instructional and experimental work; (8) acting as a bureau of information for the benefit of west of England agriculturists.

THE new session of the Birkbeck College, London, will be opened on September 28 with an address by Dr. Albert Griffiths. The new calendar, which is now available, shows that the college provides courses of day and evening instruction for degrees in arts, science, laws, and economics in the University of London, in addition to other important educational work. Twenty-eight members of the large staff are recognised teachers of the University of London. The work of the college has developed so greatly in recent years that there is pressing need for increased space. In some departments the stage has been reached where students have to be refused, and the usefulness of the college is curtailed by its limited accommodation. There is, in fact, urgent need for more spacious college buildings. We commend this calendar to intending students who live within access of the college as being likely to provide information of the kind they seek. The calendar of the Bradford Technical College for 1908–9, issued by the education committee of the city, has also been received. It not only provides full information of the comprehensive day and evening courses in technology provided at the Technical College, but also of an efficient department for external examination work, such as that in connection with the Board of Education and the Pharmaceutical Society. The volume concludes with particulars of the evening continuation schools and the branch technical and commercial schools provided throughout the city.

FROM time to time during the past six months handsome bequests to assist the development of higher education in the United States have been announced in *Science*. In addition to many gifts of 10,000*l*. or less, the following benefactions have been made. By the will of the late Mrs. Frederick Sheldon, 60,000*l*. has come to Harvard

University, and the amount will be increased eventually to something like 100,000*l.*; and the same university has also received from its class of '83 the sum of 20,000*l.* Princeton University has announced a gift of 50,000*l.* from Mrs. Russell Sage, and the University of Virginia received the same amount by the will of the late Mr. E. W. James. Mr. Andrew Carnegie has given 40,000*l.* to the Mechanics Institute of New York City and 20,000*l.* to Rochester University. The Hampden Agricultural School obtained 32,000*l.* by the will of the late Miss Alice Byington, and from that of the late Mr. Warren D. Potter the Massachusetts College of Pharmacy has benefited to the extent of 30,000*l.* The children of the late Rev. Orlando Harriman have presented 20,000*l.* to Columbia University, and Yale University has received 15,000*l.* by the will of the late Mr. G. B. Griggs. There would not appear to be any falling off in the enthusiasm shown for higher education by wealthy Americans, who continue to be fully alive to the need for well-endowed colleges throughout the States in order to fit American citizens to hold their own in the ever-increasing industrial competition.

LORD ROSEBERY opened the new engineering laboratories of the Heriot-Watt College, Edinburgh, on September 16, and delivered an inspiring address, in which he reviewed the history of the college and emphasised the value of technical training. After reminding the audience that Sir Walter Scott once said it was, in his opinion, as great a crime to hide knowledge from the people as it would be to hide the sun from them if we had the power, Lord Rosebery pointed out that the Heriot-Watt College was one of the first institutions founded in Great Britain for the express purpose of giving evening instruction to artisans, and it was the parent of all the mechanics' institutes and polytechnics that now are so rife and so much used throughout the country. It began by teaching only the principles of mechanics and chemistry and other branches of science of practical application to the several trades in Edinburgh. Now it works with the University, and gives what is practically extra-mural teaching, and while training in the evening classes corresponds to that given in the trade and commercial schools in Germany, the day college is doing the work which is done in the technical universities of Germany. Referring to the work of the day students, Lord Rosebery had something to say to employers of labour. If the number of day students could be multiplied, and if it were found possible for employers to give their apprentices days for study, besides the evenings that apprentices furnish for themselves, both the students and the employer would find their reward. If the college is ever to receive its full development, that fact will have to be recognised, and the number of day students will have to be greatly enlarged. Dealing with the training of specialists, the suggestion was made that the technical institutes in our great university towns should each specialise one side of their teaching to the extent that it would not be necessary to repeat it in other university towns, but that it could be carried to the highest pitch in each institute, and that each institute, being recognised by other local universities as regards the acceptance and reception of their students in these special branches, there would be an enormous advantage for the universities, and a vast economy of teaching power. "What a magnificent and inspiring sight is the contemplation of these thousands of students who utilise this college," said Lord Rosebery towards the end of his address. "They come, not forced, to education, as is the case in so many of our class of gentle birth, but after a day's hard work, determined, whatever their stress or fatigue may be, to utilise their evenings for the raising of their minds and the perfecting of their methods. There is no more encouraging symptom in any community than this, and if we can even contemplate the possibility of a nation in the main composed of such youths, the nation will have nothing to fear in the long run. It is on its honest and strenuous youth that every nation depends, and youth such as that, determined and resolute on its own perfection and its own efficiency, is the surest sign of the health and strength of a country."

## *SOCIETIES AND ACADEMIES.*

### LONDON.

**Royal Society,** June 4.—"The Electrical Qualities of Porcelain, with Special Reference to Dielectric Losses." By Dr. H. F. **Haworth.** Communicated by Prof. W. E. Ayrton, F.R.S.

This research was undertaken to determine some of the electrical qualities of porcelain, and their variations with respect to potential, temperature, and time. The electrical properties investigated, and the results briefly stated, are as follows:—

*A. Capacity Measurements.*

(1) The rate of charge of a porcelain condenser.

The rate of charge is comparatively slow; practically the porcelain is fully charged in one minute, if we take the first galvanometer swing as a measure of the capacity.

(2) The charge of a porcelain condenser as a function of the potential.

For potentials up to 1200 volts the charge was directly proportional to the potential, if the potential changes were made slow enough.

(3) The influence of sudden cyclical changes of potential on the charge of a porcelain condenser.

If the potential changes were made rapidly the charge was not quite proportional to the potential. A lagging effect was shown, indicating a loss in the dielectric.

(4) The dielectric constant, measured after one minute's electrification, varied with the temperature according to the following laws:—

Between 0° and 30° C., $C_t = C_0 (1 + 0{\cdot}00223t + 0{\cdot}0005t^2)$.
Between 30° and 100° C., $C_{t1} = C_{t2} . e^{0{\cdot}0264(t_1 - t_2)}$.

The dielectric constant at 20° C. was 8·95.

*B. Conductivity Measurements.*

(5) The apparent conductivity of porcelain, as measured by the ratio of current to potential, varies with the applied potential and the duration of the application. The dielectric polarises, or generates a back E.M.F., when a potential difference is applied to it. The conducting mechanism shows viscosity.

(6) The apparent conductivity of porcelain, measured after one minute's electrification, increases with the temperature according to the following law:—

$$\gamma_{t_1} = \gamma_{t_2} . e^{0{\cdot}090\,37(t_1 - t_2)}.$$

The specific conductivity at 20° C. is $0{\cdot}2624 \times 10^{-13}$ mhos per centimetre cube.

*C. Dielectric Loss Measurements.*

(7) The dielectric loss varies as the 1·74th power of the applied voltage, and is independent of the time of the cycle.

The dielectric losses at high potentials, and reasonable frequencies, may be termed hysteretic (*i.e.* independent of the time of the cycle of electrification). At very slow frequencies the loss is mainly $C^2R$ loss, and this shows viscosity effects; but these losses are swamped at working frequencies by the dielectric hysteresis.

The dielectric loss was measured by the difference of temperature which could be maintained by the central surface of the porcelain plate above atmospheric temperature. This temperature difference being only a few degrees, it follows from Newton's laws of cooling that the heat lost is proportional to this difference, and as the heat lost is equal to the heat gained, if the temperature is constant, a thermopile placed with one end in contact with the porcelain will generate an E.M.F. which is directly proportional to the dielectric loss. This E.M.F. was measured by connecting the thermopile to a low-resistance galvanometer, and noting the direct and reversed deflections to eliminate the effect of local E.M.F.'s, &c. The losses were first measured at constant frequency of fifty per second, with pressures up to 38,000 volts (R.M.S.), and were then determined at constant pressure, 30,000 volts R.M.S., and for frequencies between 15·8 and 200.

The results are summarised in the following formula:—

$$\left.\begin{array}{l}\text{Dielectric loss per}\\ \text{cubic centimetre}\\ \text{in time } t \;\ldots\ldots\end{array}\right\} = 1{\cdot}83\times10^{-12}\ V^{1{\cdot}74}_{\text{R.M.S.}}(f+14{\cdot}4)t \text{ Joule},$$

where V is the R.M.S. potential gradient per centimetre and $f$ is the number of cycles per second.

The results are illustrated with curves and tables, &c. A historical *résumé* is also given.

June 25.—"On the Atomic Weight of Chlorine." By Dr. Edward C. **Edgar.**

Three years ago Prof. Dixon and I published the results of nine direct determinations of the equivalent of chlorine. Our method was to burn a jet of hydrogen in an atmosphere of chlorine; and the number we obtained was appreciably higher than that approved by the International Committee on Atomic Weights. We found, however, when water was used to condense the hydrogen chloride formed in the flame, that some of the water vapour was decomposed by the free chlorine; so, in continuing the investigation, I avoided this by burning a jet of chlorine in *dry* hydrogen, condensing the hydrogen chloride as it was formed in a tube dipped into liquid air. In some of the experiments the hydrogen chloride formed has been weighed. My experiments (concluded in 1907) agree closely with the results previously obtained in 1905. The method employed was briefly as follows:—

A vacuous quartz combustion vessel was filled with hydrogen from a weighed palladium bulb. Chlorine was ignited by a spark at the tip of a quartz jet, and continued to burn in the atmosphere of hydrogen until nearly all the chlorine weighed had been burnt. The hydrogen chloride as it was formed in the flame condensed in a limb of the combustion vessel dipped into liquid air, and a little chlorine which had escaped burning also solidified. At the end of the combustion the residual gas was extracted by the pump and analysed; it proved to be practically pure hydrogen.

Then the hydrogen chloride was allowed to pass through a quartz tube filled with mercury vapour, where the chlorine it contained was completely removed, and the purified gas passed on to a steel bomb immersed in liquid air, where it was condensed in six experiments and successfully weighed in three. In two other experiments the hydrogen chloride was absorbed by water and weighed as aqueous acid.

In eight complete combustions about 15·5 grams of hydrogen were burnt. Taking the atomic weight of hydrogen as 1·00762, the direct ratio

$$\frac{\text{weight of chlorine burnt}}{\text{weight of hydrogen burnt}}$$

yielded the mean value 35·462 + 0·0008 for the atomic weight of chlorine, while the ratio

$$\frac{\text{weight of hydrogen chloride caught}-\text{weight of hydrogen burnt}}{\text{weight of hydrogen burnt}}$$

gave 35·461 ± 0·0009 (mean value of five experiments).

The accepted value for chlorine, 35·45, is in process of revision by the International Committee this year.

"Further Note on a Luminous Glow generated by Electrostatic Induction in an Exhausted Vessel made of Silica." By F. J. **Jervis-Smith,** F.R.S.

A glow-bulb rotating within a cylindrical inductor, end dome-shaped, placed symmetrically, with respect to the axis of rotation of glow-bulb, exhibited glow and magnetic phenomena described already (Proc. Roy. Soc., January 30; NATURE, May 21, p. 71). Sir Oliver Lodge repeated some of the author's experiments with glass bulbs, and obtained the same effects. Bulbs similar in shape and size to those described, but of pure silica, were employed. The residual gas in silica glow-bulbs was air. The glow-bulb was supported 0·5 cm. from a disc-shaped terminal of an induction coil. Opposite the bulb a pointed terminal (negative) was placed, a brush discharge played over the bulb. Coil in action, bulb illuminated with brilliant emerald-green glow. Discharge stopped, glow continued, dying out in about fifteen minutes. This remarkable after-glow could be easily seen at a distance of 4 metres from the bulb. *Glass* bulbs do not exhibit this phenomenon.

A silica glow-bulb was mounted in the rotating apparatus already described. The inductor charged from about 1800 volts to 2000 volts. The silica glow-bulb gave out a glow unlike that of the glass bulbs. In experiments with glass bulbs the glow was not strong when the inductor was charged to about 1800 volts; also, magnetic phenomena could only be seen at a distance of 0·25 metre to 0·5 metre from the apparatus; but when a silica bulb, similar in size and exhaustion to the glass bulbs, was rotated, it could be seen without difficulty in the dark at a distance of 5 metres, and when the inductor was charged up to 3000 volts to 4000 volts it was clearly visible at 15 metres from the glow-bulb.

The magnetic phenomena are the same as those which exist when a glass glow-bulb is used.

A silica glow-bulb rotated in contact with dry mercury was negatively electrified, and exhibited a greenish glow. The potential on surface reached 1500 volts, and through an applied collector charged a Leyden jar. A mercury jet playing on a silica glow-bulb caused it to glow, and negative electricity was generated.

### PARIS.

**Academy of Sciences,** September 14.—M. Bouchard in the chair.—Determination of the triple orthogonal systems comprising a family of Dupin cyclids, and, more generally, a family of surfaces with lines of curvature plane in the two systems: Gaston **Darboux.**—Some mixed forms of nuclear alterations: Joannes **Chatin.**—Observations of the comet 1908*c* made at the Observatory of Marseilles with the Eichens equatorial of 26 cm. aperture: M. **Borrelly.** Observations were made on September 3, 4, 6, 7, and 11, the positions of the comparison stars and apparent positions of the comet being determined. The comet is of the tenth magnitude.—Observations of the new comet 1908*c* made at the Observatory of Besançon with the bent equatorial: P. **Chofardet.** Similar observations for September 5.—The quadric of Lie: A. **Demoulin.**—Plane flight without motive power: Ernest **Esclangon.** Remarks on the recent notes by M. Marcel Deprez on the hovering flight of birds.—The liquid crystals of the ether salts of ergosterol: Paul **Gaubert.** The ethers of ergosterol present a liquid anisotropic phase, but with the propionate and acetate this phase is rather difficult to show, thus differing from the corresponding ethers of cholesterol.—The virulence of bacilli in relation to the course of pulmonary tuberculosis: A. **Rodet** and P. **Delanoë.** The virulence of the bacilli from a large number of tuberculous patients was tested by inoculation into rabbits and guinea-pigs. The experiments on the two animals do not lead to exactly parallel results; the two scales of virulence agree nearly absolutely at the extremes, but in the intermediate stages the concordance is not so good. There is a distinct relation between the virulence as shown by these experiments on animals and the course of the disease in the patients from whom the bacilli were derived. Predisposition of the tuberculous patient is not the only factor in determining the course of the disease; the virulence of the bacillus is also a determining factor.—The intra-dermo-reaction with tuberculin in animals: G. **Moussu** and Ch. **Mantoux.** The intra-dermo-reaction, if practised in the manner described, is absolutely without any effects on healthy animals; in the case of tuberculous animals there is no general thermal reaction and no interference with the general health, and the method appears to be very certain in its indications.—Some physiological properties of the muscles of invertebrates: Jan **Sosnowski.**

### CALCUTTA.

**Asiatic Society of Bengal,** September 2.—A polyglot list of birds in Manchu, Chinese, and Turki, part ii.: Dr. E. D. **Ross.** In 1877–8 Robert Shaw published in the journal of this society a grammar and vocabulary of the Turki language. At the end of the vocabulary was printed a list containing upwards of 150 Turki names of birds with their identifications, prepared by Dr. Scully, who accompanied the second mission to Yarkand. The present paper forms the introduction to a memoir on the birds of Central Asia which is, in a manner, a supplement to Dr. Scully's list. The British Museum possesses a very valuable MS. in many volumes containing an exhaustive vocabulary in five languages, viz. Manchu, Mongolian, Tibetan, Turki, and Chinese, on every conceivable topic. The memoir, to which the present paper is an introduction, contains a transcript of the section on birds, omitting the Mongolian and Tibetan versions. Three hundred and fifty birds are enumerated. With the object of adding to the knowledge of the Turki language, and with the view of collecting and identifying as many Turki birds as possible, the writer has prepared an index containing not only all the bird names mentioned in the polyglot list and by Scully, but which further comprises all the bird names he has been able to find in Turki dictionaries and other works. The index contains 650 bird names, of which more than half have been more or less identified.—The retardation and acceleration in the dissolution of mercury in nitric acid in the presence of minute traces of ferric nitrate and manganous nitrate: Prof. P. C. **Rây**.

### CAPE TOWN.

**Royal Society of South Africa**, August 19.—Mr. S. Hough, F.R.S., president, in the chair.—The application of Doppler's principle to astrophysical problems: Dr. J. K. **Halm**. The importance of this principle in determining the motions of the celestial bodies in the line of sight by means of the displacements of the lines of their spectra from their normal positions was dealt with, and its application was illustrated by such examples as binary stars, Saturn's rings, the rotation of the sun, and the motion of the earth in its orbit round the sun.

### NEW SOUTH WALES.

**Royal Society**, July 1.—Mr. W. M. Hamlet, president, in the chair.—Records of Australian botanists: (*a*) general, (*b*) New South Wales: J. H. **Maiden**. The author is endeavouring to do for Australian botanists what Britten and Boulger have done for British ones, and publishes many details concerning them for the first time. He omits references to living men, and also to the French botanists who did so much for Australia in the early years of settlement; he proposes to deal separately with these on some future occasion. The term "general" has been taken to include those botanists who have dealt with the plants of all the States or in more than one of them; the present paper gives a separate account of New South Wales botanists, and the author is making arrangements for the publication of the records of the botanists of the other States in those States.—The elastic substance occurring on the shoots and young leaves of *Eucalyptus corymbosa* and some species of Angophora: Henry G. **Smith**. The author records the results of a chemical investigation of this elastic substance, which is formed at the time the shoots are developed. As the buds expand, and the individual leaves are formed, the elastic coating stretches and expands with them. Changes then rapidly take place as the need of the protective coating is removed, and by light and oxidation a white powdery substance is formed, which remains on the surface of the leaves, and although no white coating can be detected upon the mature dull green leaves of this group of Eucalypts, yet it can readily be removed by ether with only five minutes' contact. A small quantity of a vegetable wax is formed at the same time, and this can be removed from the powdery substance by solution in boiling petroleum ether, and purified from boiling alcohol. As the genus Eucalyptus descends, and that group having white pulverulent young growth is reached, including such species as *E. cinerea*, *E. pulverulenta*, *E. globulus*, &c., then it is found that the wax has increased considerably in amount, and that the white appearance of these young leaves is due to the presence of a comparatively large amount of this wax, together with the white substance found on the leaves of the earlier members of the genus. The reason why the leaves of the "bloodwoods" (to which group *E. corymbosa* belongs) are not pulverulent is that there is a deficiency of the wax. In those species where the wax predominates, the elastic substance does not occur, the corresponding protective medium being supplied by the wax. The amount of material removed from the fresh young leaves of *E. corymbosa* by ether was equal to 0·84 per cent., of which 0·0224 per cent. was wax. From the fresh young leaves of *E. cinerea* the total removed was 1 per cent., of which 0·355 per cent. was wax. The elastic substance was found to be a very good form of caoutchouc, thus bringing the Myrtaceæ into those families of plants yielding this substance, and showing that both Eucalyptus and Angophora are "india-rubber" bearing plants. The best solvent was found to be chloroform, as the other usual solvents acted but little upon it. The sheet rubber obtained by the evaporation of the chloroform had great elasticity, did not melt below 250° C., and quickly regained its elasticity on cooling. In every other respect it acted as did crude commercial "rubbers." The rubber was also obtained from the plant by destroying the leaf substance by allowing the material to remain for five days in a 5 per cent. solution of potash, and removing the "rubber" by mechanical means. When heated in melted sulphur it vulcanised very well. If Eucalyptus "rubber" was obtained in quantity it would have considerable commercial value. This, however, from the natural plant is not possible, as the collection would be too costly, without considering the rapid alteration it undergoes on the leaf.

## CONTENTS.

THURSDAY, OCTOBER 1, 1908.

## MATHEMATICAL ASPECTS OF ELECTRICITY AND MAGNETISM.

*The Mathematical Theory of Electricity and Magnetism.* By Prof. J. H. Jeans, F.R.S. Pp. viii + 536. (Cambridge: University Press, 1908.) Price 15*s.* net.

ELECTRICITY and magnetism now form so vast a subject that their mathematical aspects cannot be all dealt with in a single volume even of the present size. Thus a choice has to be made by the author, and one's estimate of his success naturally depends to some extent on what one believes most appropriate for the type of reader whose wants he professes to supply. In his preface the author tells us that whilst his work covers much the same range as Maxwell's treatise, it is in many respects more elementary; that it is not, like Maxwell's great work, for the fully equipped mathematician, but more especially for the student and for the physicist of limited mathematical attainments.

The difficulties experienced by a good mathematician in Maxwell's treatise arise more from what it omits than from what it contains. The difficulty lies in following Maxwell's train of thought, and in seeing what exactly it is he is trying to prove. There is a substantial substratum of truth in the remark once made to the writer that it would have been an immense improvement to Maxwell's "Electricity" to have been written by Routh. Maxwell's treatise is a work of genius, but it never was a good text-book for students. The distinguished editors of the second and third editions have very naturally treated the treatise as a species of sacred writing, not to be lightly modified even in details, and though Prof. J. J. Thomson's "Recent Researches" appeared as a supplementary volume to the electrical part, it is not a complete treatise in itself. Thus there does appear room for a complete mathematical treatise in English, such as might be written by an accomplished mathematician who had the time, the knowledge, and the natural gifts necessary for clear exposition. The production of such a book, it may be added, need not be regarded as showing any lack of reverence for Maxwell's memory.

Now it seems to the present writer that while Prof. Jeans's eye when he started writing may have been focussed on the reader of "limited mathematical attainments," it gradually extended its range of vision until it viewed in the distance, though but dimly, the complete treatise hinted at above. The result is that the book seems not unlikely to reduce the self-esteem of any conscientious reader of limited mathematical attainments who has no one at hand to advise him what to omit, at least for a first reading.

Chapters i. to viii., pp. 5–294, *i.e.* more than half the book, are devoted to electrostatics. This apparent disproportion the author ascribes to space being given in chapter viii. to the explanation of the mathematics of spherical and ellipsoidal harmonics, conjugate functions, Schwarz's transformation, and similar matters. This chapter is a very long one, dealing also with inversion and the theory of images, and containing the solution of problems which illustrate the various methods. Chapters ix. and x. deal with currents, mostly steady currents; chapters xi. and xii. treat of "permanent" and "induced" magnetism, including a few pages on terrestrial magnetism. Chapter xiii. deals with the magnetic field produced by steady currents, chapter xiv. with the induction of currents in linear circuits, make and break currents and oscillatory discharges, and chapter xv. with the induction of currents in continuous media and current sheets. The three last chapters, xvi., xvii. and xviii., treat of Hamilton's principle, Lagrange's equations, the general electromagnetic equations, and the electromagnetic theory of light.

An important feature of the book is the insertion of examples for the student at the end of most of the chapters. In all, there are some 250 of these, varying much in difficulty, but mostly of the type characteristic of Cambridge college and university examinations. Another feature is the insertion of numerical results in the text illustrating the size of practical electrical units; these should reduce the risk of mistakes in applications of general formulæ. There are not infrequent references in the text to physical results calculated to warn the student against improper applications of the mathematical theory, but they do not always seem quite adequate. The statement, for instance, p. 400, that magnetic permeability in iron continually increases as temperature is raised up to the point of recalescence is too general. At the end of each chapter is a list of authorities. These lists are, however, mainly devoted to stating which precise part of a few English books (especially Maxwell's treatise and J. J. Thomson's "Elements") deals with the subject of the chapter. A single really good name-index would probably be more generally useful. In the absence of a name-index, the general index, pp. 532–6, seems hardly adequate. It does not contain, for instance, the names of Kelvin, Larmor, Lodge, Rayleigh or Thomson. Amongst the subjects to which little space is devoted are methods of measurement and comparison, the theory of instruments, problems relating to dynamos, electric lighting or traction, and electrical engineering generally, rapidly alternating currents, detailed theories of electrons or moving charges, atmospheric electricity and conduction in gases.

The printing and general appearance are what one expects of the Cambridge University Press. Even Cambridge proof-readers, however, must occasionally miss something, *e.g.* $\delta^2V/\delta x$, p. 59, and $\iiint dS$, p. 372.

The signs attached to the Gaussian constants $B_{11}$, $B_{42}$ and $B_{41}$ (Neumayer's values) in art. 456 appear to be wrong; but $B_{11}$ is given the correct sign in art. 457. It seems curious, by the way, that, notwithstanding the great prominence given to Cambridge sources of information, there is no reference to J. C. Adams's great work on the Gaussian constants, or to Shelford Bidwell's article on magnetism in the *last* edition of the "Encyclopædia Britannica" (Prof. Jeans's references seem all to the ninth edition).

In a few cases there are slips which can hardly be assigned to the printer, *e.g.* in the analysis of art. 520, but few such have been noticed. In conclusion, it may be said that in the opinion of the present writer the type of reader for whom the book is best adapted is the student preparing for a mathematical examination, such as the Cambridge Tripos, in which theory plays the principal part. It should also, however, prove a good book of reference to the physicist of superior mathematical attainments. For either of these types of readers it seems likely to be a really useful book, so far as its scope extends.

C. Chree.

## *PETRELS.*

*A Monograph of the Petrels (order Tubinares).* Parts i., ii. and iii. By Dr. F. Du Cane Godman, F.R.S. With hand-coloured plates. (London: Witherby and Co., 1908.) Price 2*l.* 5*s.* per part.

We welcome another instalment of the finely illustrated "monographs" in which ornithologists are gradually, if slowly, writing the history of the birds of the world. The latest of these monographs to be launched is founded on the synopsis of the order Tubinares, published by the late Mr. Salvin in the twenty-fifth volume of the "Catalogue of the Birds in the British Museum." It was Mr. Salvin's intention on the completion of that work to have issued a series of coloured illustrations representing all the species of petrels, shearwaters, fulmars, diving petrels, and albatrosses, which constitute the order Tubinares, and at the time of his death in 1897 many of the plates had been prepared. The present author has had the series of coloured plates completed, and he is now issuing them in the form of a monograph, adding such synonymy and accounts of the geographical distribution and habits of the species as Mr. Salvin originally intended, and bringing the work up to date.

Since the twenty-fifth volume of the British Museum Catalogue was issued in 1896, considerable additions to our knowledge of the Tubinares have been made. Some remarkable discoveries have been made by American ornithologists in the seas of California and the islands which lie off the south-western coast of North America, and Sir Walter Buller's supplement to the "Birds of New Zealand" has added to our knowledge of the group. Moreover, from the observations made by the naturalists to several recent Antarctic expeditions, we have learned a great deal about the breeding habits of certain well-known species, which, retiring to those inhospitable regions for the purpose of reproduction, had up to then managed to keep us very much in the dark as to the manner of their nesting. The material thus examined has enabled the author to undertake the revision of the Tubinares with some confidence. The order as at present known embraces more than one hundred species.

The first three parts of the work are now in our hands, and fully carry out so far as they go the objects set forth in the author's note. The first part deals with the smaller petrels of the following genera:—Procellaria, Halocyptena, Oceanodroma, Oceanites, Gorrodia, Pelagodroma, Pealea, and Cymodroma (in part). First on the list comes our own familiar stormy petrel—the petrel *par excellence*—of which a very good and concise history is given, including synonymy, geographical distribution, breeding, and general life habits, and a full description of the plumage of the adult and young; and this is the general plan of the work.

Twenty-four species are treated of in sixty-eight pages of letterpress, and there are twenty coloured plates. Part ii. concludes Cymodroma, and deals with twenty-four species of the large genus Puffinus, the shearwaters, in sixty-four pages, with twenty coloured plates. In this part may be noticed the great shearwater, of which, though the bird was known to Latham so long ago as 1785, and although it sometimes appears in large numbers off our own coasts, the breeding place is still unknown. It can scarcely, however, be doubted that this must be sought for in southern latitudes, and in our winter.

Part iii. concludes Puffinus, and treats of four restricted genera and twenty-three species of the extensive genus Œstrelata. Among the former we find the silvery-grey fulmar of the southern oceans, which in general appearance so much resembles the fulmar of the north that Latham and Gmelin described it as a variety of that species. Also the great dark-coloured petrel familiarly known to sailors as the Cape Hen. The casual occurrences of *Œstrelata haesitata, Œ. brevipes,* and *Œ. neglecta* in the British Islands are wonderful instances of the wandering habits of these small fulmars. The accounts given of the breeding and general life habits of these ocean wanderers, the gliding flight of which has so often beguiled the monotonous hours of the passengers on liners, are very interesting; and those who often have occasion to go on long voyages (in the southern seas especially), and take an interest in the birds they see, would do well to study the plates, at all events, in this fine work, and so have a chance of learning (roughly speaking) the names of the petrels which may on some days be seen from the deck in great numbers. But specimens of these birds are very rarely secured, and no opportunity should be lost of preserving any that by a lucky chance should come into the traveller's hands; for some species are known from single specimens only, and others from but little more.

The work will be completed in five quarterly parts. It is beautifully printed on rag paper, and we need only say of the plates that they are by Mr. Keulemans, and drawn and coloured under the most careful supervision. This means that they are as near perfection as it is possible for ornithological plates to be.

O. V. A.

## *OUR BOOK SHELF.*

*Das Weltgebäude, Eine gemeinverständliche, Himmelskunde.* By M. Wilhelm Meyer. Zweite, umgearbeitete Auflage. Pp. xii+691. (Leipzig and Vienna: Bibliographisches Institut, 1908.) Price 16 marks.

Ten years ago we read the first edition of this work with considerable satisfaction, and the examination of the second edition has been interesting, since it shows how much astronomical science has advanced in the interval, and demonstrates the necessity of frequent revision of popular text-books of this character. In some respects the work has already fallen behind—inevitable from the time required to pass such a book through the press—and though an appendix is not a convenient form for supplying the most recent information, it might have been adopted here with advantage. If we may trust the index and a very careful scrutiny of the text, there is no reference to the eighth satellite of Jupiter. On the same grounds we think that justice has not been done to the energy and success with which Prof. Hale has pursued his investigations, and the references to Sir David Gill are meagre. Altogether the revision does not seem to have been made with sufficient thoroughness; there has been too great a reluctance to sacrifice the material prepared for the earlier edition, with the result that the author has retained references to earlier work which has been superseded by the employment of larger means and greater experience. But though one may regret that in some particulars the work might be improved, it still possesses very high claims to consideration. The main facts are presented in an admirably attractive manner, leaning perhaps, where opportunity offers, to the sensational side; but nevertheless the description is trustworthy, likely to captivate the amateur, and gain recruits to the study of astronomy.

The book is divided into two parts, the first devoted to purely descriptive astronomy, the other to explaining the motion of the heavenly bodies. In the first part, after an introduction explaining the optical principles of the telescope and its application to photography and spectrum analysis, we have a series of chapters describing the several members of the solar system, including comets and meteors, and finally the sun itself. Next follows a description of the stellar universe, separate chapters being assigned to the classification of stellar spectra; the nebulæ and star clusters; the Milky Way; double and variable stars. In this section the author's task is comparatively simple. No material fact must be omitted; but in the second part, that treating of motion, he has to exercise selection, both of the subject itself and its method of treatment. Mathematical completeness is impossible, and therefore the chapters on planetary motion, solar parallax, aberration and precession, are scarcely satisfactory. But readers for whom the book is intended will no doubt find the treatment adequate, and those who desire a more thorough discussion would not look for it here.

*Practical Coal Mining.* By Leading Experts in Mining and Engineering. Edited by W. S. Boulton. Divisional-volume v. Pp. viii+176. (London: The Gresham Publishing Company, n.d.) Price 6s. net.

IN NATURE of May 23, 1907, and of March 19, 1908, notices were published of previous instalments of this work, which, when completed in six volumes, is intended to cover the whole ground of modern coal-mining practice. Each section of the work is written by a different author, a division of responsibility that renders a certain want of harmony in the treatment of the subject-matter inevitable. This defect is less noticeable in the present volume than in the four preceding volumes. Mr. James Ashworth's contribution on lighting covers 56 pages, with 125 excellent illustrations, and gives a concise review of the history of the safety lamp, and of the safety lamps in use at the present day. The importance of lamp housing is urged, and useful rules are given for the use of safety lamps. Mr. W. Galloway devotes 70 pages with 30 illustrations to a masterly essay on colliery explosions and rescue appliances. This contribution is also issued separately by the publishers. The subjects of fire damp, blasting, coal dust and rescue appliances are fully discussed. Mr. Galloway's new departure in the method of explaining great colliery explosions whereby coal-dust is elevated to the rank of principal agent was received unfavourably and long rejected by many as illusory. Now, even the French engineers, after the Courrières explosion, have come into line with those of other countries, after having strenuously opposed the so-called coal-dust theory for thirty years. Mr. H. F. Bulman gives a brief account of mineral holdings, covering 20 pages. Lastly, there is the beginning of what promises to be a most useful section on mine surveying by Mr. L. H. Cooke.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### Photographs of Comet *c* 1908 at the Royal Observatory, Greenwich.

LONG-EXPOSURE photographs of comet *c* 1908 have been obtained with the 30-inch reflector on September 6, 7, 8, 14, 17, 18, 21, 25, and 26, the exposure ranging from forty-five minutes to an hour (except on September 14 and 25, when exposures of twenty minutes were made). The comet possesses a bright tail, the structure of which is well shown in the photographs, to a distance of $1\frac{1}{2}°$ from the head. The appearance of the tail changes greatly from night to night, so that photographs taken at much shorter intervals than a day are desirable in order to trace the alterations in structure continuously. With this in view, on September 17 three photographs, with exposures of forty-five minutes, were taken at intervals of approximately an hour (reckoned from the middle of each exposure); decided change had occurred between the first and last photographs, and the middle photograph served to show how the transition had taken place. Efforts are being made to obtain a series of photographs at short intervals extending throughout a night, but so far the full moon and the weather have prevented this.

A photograph taken on September 21 with a portrait lens of 11 inches focus showed the tail extending to a length of 4°.

W. H. M. CHRISTIE.

Royal Observatory, Greenwich, September 28.

### Library Cooperation in Regard to Scientific Serials.

ABOUT two years and a half ago a short paper of mine on "Library Aids to Mathematical Research" was fortunate enough to attract a little passing attention, the object of it being to bring about friendly cooperation among the public libraries of a city or district with a view to prevent waste in the purchase of duplicates, and thereby to make a greater number of serials accessible to research students. Of course, it was intended that this cooperation should be accompanied by the publication of a hand-list giving the names of the serials, and showing workers in what libraries any given serial was certain to be found. In NATURE in particular the matter received sympathetic consideration (see vol. lxxiii., pp. 372, 413, 438, 464, 513), and from the eminence of the correspondents hopes were raised that something practically valuable would be the outcome.

In the matter of *voluntary cooperation* among the libraries, exceedingly little would seem to have been effected, and the place where the need is greatest, London, appears to be as far off as ever from possessing a reference-library in which could be consulted the whole of the literature indexed in the Royal Society's Catalogue of Scientific Papers and in the International Catalogue.

As regards the production of a *hand-list of serials*, however, a most important step has been taken, the Royal Society having decided to preface each volume of its great subject-index with such a hand-list, and having actually carried out its decision in the case of the first volume. In this volume, which has recently appeared, and in which the pure mathematics of the nineteenth century is the subject, the list extends to forty pages, and includes the titles of 700 serials, every serial's name being followed by initials indicating some library or libraries in London, Cambridge, Oxford, Dublin, Edinburgh, or Glasgow where the serial is to be seen. This list, like the index which it precedes, is an immense boon to mathematicians. All honour to those concerned in its preparation, and may the other volumes soon follow!

What now remains, in order to satisfy the reasonable demands of students of mathematics, is the preparation of a one-page supplement making the list complete up to the present day. There may be differences of opinion as to what such a supplement ought to include. My original proposal to the London Mathematical Society in 1904 was to take as a guide the list of journals published by the council of the International Catalogue, and to the extent of one subject Prof. Armstrong's ideal would thus be attained. A more thorough course would be to associate with this list the corresponding lists which form the bases of the *Jahrbuch uber die Fortschritte der Mathematik* and the *Revue semestrielle des Publications mathématiques*. Doing this, I find that our supplement, to be exhaustive, would need to include between thirty and forty entries instead of four-and-twenty; as, however, a number of these would concern journals of a very elementary character, the most prudent course at the outset might be to select only those that are included in *all* the three lists. The number thus reached would be a dozen, and the following are their names:—*American Mathematical Monthly, L'Intermédiaire des Mathématiciens, Revue de Mathématiques spéciales, Zeitschrift f. math. u. naturw. Unterricht, Abhandl. zur Geschichte d. math. Wiss., Mathematikai és Phys. Lapok, Periodico de matematiche . . . , Supplemento al Periodico . . . . Il Pitagora, Boll. di Bibl. e Storia delle sci. mat., Tōkyō sugaku Butsurigaku Kwai Kiji, Proceedings of the Intern. Math. Congress.* Some even of these may not be very important, but surely so long as mathematicians are referred to them by the three standard annuals above mentioned it is eminently desirable that one should know where they can be consulted. Libraries, therefore, which possess sets of them should make themselves known at such a centre as the office of the International Catalogue, where possibly a suitable opportunity might present itself for placing the information at the disposal of the public. THOS. MUIR.

Cape Town, S.A., September 1.

## Research Work on Natural Indigo.

My attention has been directed to a review of the report on indigo research work at Leeds University, recently made by Mr. Bloxam and others to the Government of India, which appeared in your issue of July 30. In the course of this review Prof. Meldola directs attention to the contention, which has been made by Mr. Bloxam, that, by means of new and improved methods of analysis, he has shown that there is yet scope for considerable improvement in the process of indigo manufacture. Prof. Meldola believes that a good case has been made out, and severely criticises the planters, and those who have advised them, for having neglected to take advantage of the possibilities which have been indicated by Mr. Bloxam's work, since he considers that therein lies the sole hope of the salvation of their industry.

As representing the planting community of Bihar, I feel bound to say a word in our defence and in that of our advisers. We cannot agree with Prof. Meldola that the only hope of the survival of our industry lies in a realisation of the possibilities which Mr. Bloxam believes to exist in the improvement of our process of manufacture. This process has, indeed, been considerably improved in recent years, and, thanks to this, to changes in our agricultural practices, and to the substitution of the Java for the Sumatrana plant, we are now in a position to turn out our indigo at half its former cost, and we have every reason to hope that, with a few seasons of favourable climatic conditions, we shall be able to compete with the synthetic product at the lowest price at which it is likely to be able to be produced. There is also, as Prof. Meldola points out, a biological side to our problem, and we anticipate that investigation from this aspect, which is yet in its infancy, will ultimately lead to considerable further benefit.

But it is nevertheless totally unjustifiable to describe our attitude towards Mr. Bloxam's work as a hostile one. It is perhaps true that we delayed calling in scientific aid to our industry too long, but investigations directed towards the improvement of indigo manufacture have now been in progress in India for ten years, and as a result of these investigations and by the aid of the new methods which have been introduced, our scientific advisers now tell us that nothing further can be done in improving the main processes. As practical business men we are inclined to accept this verdict rather than the opposed one, *not* because it mitigates our "past neglect," for surely it would not do so even if no improvement on our original process had been found possible (which is far from being the case), but because it seems to us more probable that investigators on the spot, who have been daily handling the fresh plant and the products of manufacture for a term of years, are more likely to be in a position to form a correct opinion than those who have dealt with preserved material for a comparatively short period. Further, it would seem that no motive other than an honest conviction could influence those who declare that their work has reached a conclusion.

We are, of course, totally unable to judge of the scientific arguments which have been advanced on either side in the recent controversy, but it is doing the gravest injustice to those who have advised us to imply, even remotely, that they have chosen to disregard the researches at Leeds lest they should disprove their own contentions. Far from having "deliberately brushed aside" the conclusions drawn by Mr. Bloxam and his colleagues, our advisers have devoted a great deal of time to close examination of the evidence whereon these conclusions are based. They have satisfied themselves that this evidence is erroneous, and continued investigations of the crucial points at issue have only served to confirm their original views. Nevertheless, they have repeatedly impressed upon us the enormous benefit which might accrue to our industry even if Mr. Bloxam's contentions were only partially correct and became realisable in practice, and they have urged us to use every effort to obtain an entirely independent opinion in the matter for this reason, and in spite of their settled conviction that such independent opinion is bound to confirm their own. It is solely owing to this urging on their part that we have taken steps to do this. T. R. FILGATE.

(General Secretary, Bihar Planters' Association.)

Mozufferpore, August 26.

I CAN assure the secretary of the Bihar Planters' Association that the comments upon their neglect of scientific method when they were first brought into competition with synthetic indigo which I felt bound to make were prompted solely in the interests of the native industry. It is practically conceded in the foregoing communication that there has been such neglect, and that the practical outcome of the revision of their processes has been the halving of the cost of production of the natural product in the course of a few years. This is satisfactory so far as it goes, but the main issue is still left very doubtful. In spite of the reduction of the cost of production by one-half, it appears that they are still in India at the mercy of climatic conditions, and even then, supposing these to be favourable for a few seasons, they have only "every reason to hope" that they will be able to compete with their coal-tar rival. Those who have at heart the welfare of our Indian Empire will cordially endorse the wish that their hope may be realised, but the point at issue between the report to the Indian Government and the Planters' Association is really whether finality has been reached in the way of improvement. According to the statement of the secretary, they have been advised that no further improvement in the "main processes" is possible. The results of the application of the newer methods of analysis indicate clearly enough that there is more indigotin in the plants than has hitherto been suspected. The advisers to the association certainly do "brush aside" this work done at Leeds if they authorise the secretary to state "they have satisfied themselves that this evidence is erroneous." Those who in common with myself have looked critically and, I may say, quite impartially into the evidence have come to the conclusion that the analytical methods are quite dependable. Others will no doubt corroborate this statement. After the publication of the report the Planters' Association held a meeting, at which they passed a resolution expressing confidence in, and practically endorsing the opinion of, their own advisers, in face of the new evidence offered from the Leeds laboratory. I gathered this information from a report of the meeting in one of the Indian papers, which was forwarded to me at the time. This attitude, which may fairly be described as one of hostility, would have been stiffened by the above letter were it not therein admitted that the "biological side" of the problem is still in its infancy, and that further development in this direction is anticipated. Also it is conceded that "an entirely independent opinion" in the matter (? of the manufacturing processes) is to be obtained. Thus all the contentions of those who felt the ignominy of this great Indian industry "taking its whipping in a crouching attitude" are likely to be met, and our best wishes are, it is needless to say, with the planters. If they are, by the inexorable laws of nature, beaten in the long run, it will at any rate redound to their credit that they did not succumb without a good fight.

There is one point in the foregoing letter which appears of considerable importance, and to which I should like to take the present opportunity of directing attention. The evidence of the advisers to the association is accepted because it appears that they are on the spot and dealing with the fresh plant, while the Leeds chemists have been investigating "preserved material." Now if the Leeds results by the isatin method are correct—and I repeat that I see no reason to doubt them—it follows that "preservation" leads to an increased development of indican. May not this hint be worth following up practically? In thanking the secretary of the association for his communication, I should like, in conclusion, to repeat what I said during the discussion before the Society of Chemical Industry last autumn. The results given by the newer methods of analysis may be unrealisable in practice; it does not follow that because a certain percentage of indican is present in an Indigofera leaf the corresponding quantity of indigotin, or anything approaching that quantity, can be got out of it in the factory. All that is contended is that at the present juncture the indications furnished by a scientific quantitative method render it imperative that every resource should be strained to save the native industry. Further developments will be anxiously waited for in this country.

R. Meldola.

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I entirely agree with the opinion expressed by Prof. Meldola in his article, entitled "A Contribution to the Indigo Question," which recently appeared in Nature (p. 296), that the case had "at one period assumed a polemical aspect most detrimental to the real cause at issue," and I write this with no desire to discuss the responsibility for this regrettable state of affairs, or to revive it. My object is to record some results recently obtained by Mr. Briggs and myself, which we had not intended publishing, but which may prove of interest in the light of Prof. Meldola's article.

Anhydrous indican was prepared according to the method of Perkin and Bloxam (Journ. Chem. Soc., vol. xci., p. 1715); its melting point was, as stated by these authors, 176–178°. A gram of this substance was dissolved in 500 c.c. of water. Two 100 c.c. samples were withdrawn from this solution, and analysed by the isatin method of Orchardson, Wood, and Bloxam (Journ. Soc. Chem. Ind., vol. xxvi., pp. 8 and 1178), and two by the persulphate method of Bergtheil and Briggs (Journ. Soc. Chem. Ind., vol. xxv., p. 734, and vol. xxvi., p. 1173). This was repeated three times with two distinct preparations of indican. The following results, expressed as the amount of indigotin (in grams) to be derived from 100 c.c. of the solutions, were obtained. The figures are means of the duplicate experiments, which agreed very closely.

| | Isatin method | Persulphate method | Theory |
|---|---|---|---|
| i. | 0·0841 | 0·0840 | 0·0888 |
| ii. | 0·0855 | 0·0845 | |
| iii. | 0·0852 | 0·0845 | |

The indirubin obtained by the isatin method was analysed by titration with titanium chloride (Knecht) in each case, and found to be 98 per cent. pure (average of six samples); the titanium chloride solution was standardised on pure iron, and also on pure indigotin obtained by sublimation under reduced pressure (Bloxam).

The indican employed was evidently not pure, the analyses indicating a purity of 94·6 per cent. in the first case, and 95·6 per cent. in the second and third, but this degree of purity is sufficiently high for the purpose of comparing the methods. The comparisons indicate that almost identical results are obtained, the mean difference being 0·7 per cent.

Another point which these figures seem to establish is the accuracy of our method of determining indigotin (at any rate, so far as the factor for the relationship between indigotin and permanganate is concerned), for it is extremely improbable that, were an error involved in this method, it would be so exactly counterbalanced by errors in the other direction in the precipitation of indigotin by persulphate as to bring the results into such close approximation with those obtained by the isatin method.

If these two points are conceded, then the main grounds on which the contention is based, that "the older methods have overestimated the indigotin content of the dried cake, and have underestimated the amount of indican in the leaf," disappear. C. Bergtheil.

Sirsiah, September 2.

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## An Alleged Excretion of Toxic Substances by Plant Roots.

Since the communication entitled "An Alleged Excretion of Toxic Substances by Plant Roots" appeared in Nature (August 27, p. 402), it seems desirable to state the exact position taken by the Bureau of Soils on the question of deleterious substances in soils and root excretions.

Abundant evidence has already been presented to the effect that substances deleterious to plant growth do exist in many soils, and are mainly responsible for the infertility therein observed,[1] and toxic substances, to wit, picoline carboxylic acid and dihydroxystearic acid, have actually been isolated and identified. In carefully controlled experiments these toxic conditions have been shown to arise as the result of the continuous growth of the same sort of plants upon the soil. In addition, it has been shown that plants like wheat excrete substances which set up toxic conditions in the medium. Toxic conditions may also arise from the presence of the decomposition products of vegetable matter in the soil. Indeed, it has been shown that very many substances naturally occurring in plants are toxic in quite small amounts. When plants containing these substances are incorporated with the soil, they may play an important *rôle* as soil constituents.

Regarding the criteria of growth, it may be said that not transpiration alone, as implied in the article referred to, but several standards of growth were employed in the investigations of this bureau, viz. weight of green tops, dry weight, transpiration, turgidity and colour of roots, chemotropic response of the roots. All these criteria are employed in determining the physiological effect of substances on plants, but no one is regarded as absolute.

The statements made in Bulletin No. 48 of this bureau were based, as was said in the note referred to, upon many thousands of pot experiments, and the conclusions seem justified by the results of that work. It is obviously possible to choose figures from any table which are apparently discordant. A comparison of the paraffin pot method of testing soils with the results of continuous plot experiments in this country has shown good agreement.[2]

Howard S. Reed.

Agricultural Experiment Station, Blacksburg, Va.

[1] Bulletins Nos. 28, 36, 40 and 41 Bureau of Soils; Rept. Hawaii Agr. Exp. Sta., 1906, p. 37; Journ. Biol. Chem., iii., Proc. 38 (1907); Journ. Amer. Chem. Soc., xxx., 1295 (1908); *Science*, xxvii., 190, 295, 328, 329 (1908).

[2] Bull. 109, Rhode Island Agr. Exp. Sta.

## SURVEYING FOR ARCHÆOLOGISTS.[1]

### IV.

### *Simple Instruments for Measuring both Magnetic Azimuth and Altitude.*

ALTHOUGH undoubtedly for final observations at any monument a theodolite must be employed, using the sun or a star in order to obtain astronomical

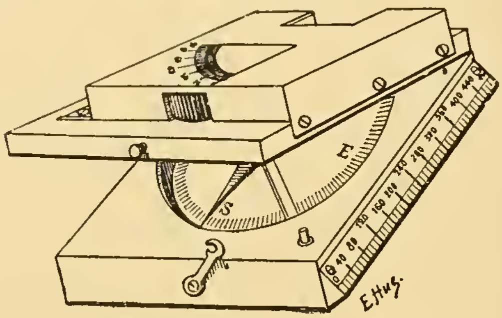

FIG. 13.—M. Hue's combined compass and clinometer.

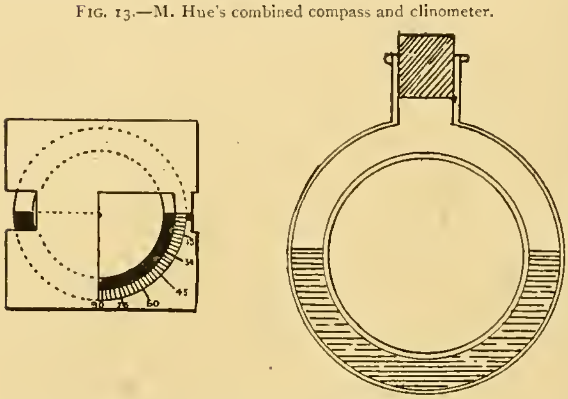

FIG. 14.—Details of the water-level clinometer.

or true bearings and so avoid all magnetic difficulties, and reversing the telescope to secure the correct altitude of the horizon; for rapid surveys there are many handy forms of instrument by means of which preliminary information can be gathered, both with regard to azimuth and, what is equally important, the angular height of the horizon.

It is quite certain that the use of the prismatic compass, in spite of its great convenience, must give way to other instruments which enable us to determine approximately the altitude of the horizon as well as the azimuth of any object the bearing of which we wish to obtain.

As a matter of fact there are now several such instruments available. They consist in the main of an azimuth compass, with an addition generally called a clinometer, enabling angles to be measured in a vertical plane. For this addition the first requisite, of course, is to be able to determine the true horizontal plane at the place of observation. This can be done by using a water level, a pendulum, or a properly adjusted bubble. I will give a brief description of three instruments which are based upon these various methods.

For the angular measurement of elevation, including, therefore, the angular height of the horizon as seen from any monument, the archæologist may use a very simple and convenient addition to the compass devised by M. Hue, a distinguished French archæologist. He uses the water-level principle. The method employed can be readily gathered from the accompanying woodcuts, obligingly sent to me by the publishers of the "Manual of Prehistoric Researches," published by the Société préhistorique de France; a book which shows us, by the way, that the French archæologists are much more thorough and philosophical in their inquiries than their British brethren. It is not a question of the spade *versus* the theodolite, but of the spade *and* the theodolite, and as full instructions are given about one as about the other.

It is quite refreshing to read the chapter "Indications pour faire un levé de Terrain à la Boussole," and then the instructions given relating to subsequent work with the large-scale maps published by the French Government.

In Barker's instrument, called for short a clino-compass, we find the pendulum method employed. The altitude zero of the instrument is shown when the pendulum hangs vertically at rest. This is an addition to the azimuth compass, and can be used when the azimuth measures have been made by making the plane of the instrument vertical. The figure will show the method of use. The degrees of elevation can be read under the prism as well as by the pointer at the bottom.

In a reconnaissance lately among the Aberdeen circles I employed a clino-compass of Barker's pattern; it weighs only a few ounces and is carried in a sling over the shoulders; even a tripod can be dispensed with, though it is much better to have one; the lightest form is that supplied by the Kodak Company for their cameras, to which must be added an adapter at the top to fit the base and allow the instrument to be used horizontally and vertically. In this form, especially in the case of the altitudes, the mean

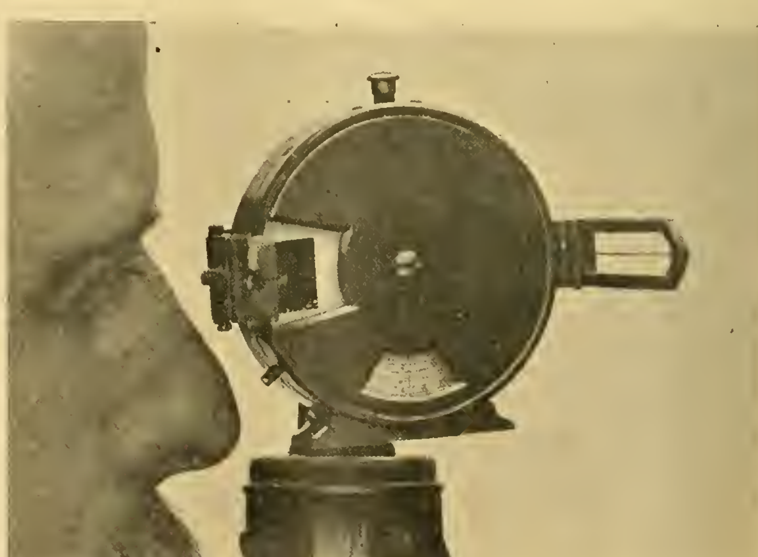

FIG. 15.—Vertical readings with Barker's clino-compass. An elevation of 3° indicated.

of several observations should be taken. In my opinion, a desideratum for such work is a simple small instrument with level and reversible telescope for small

[1] Continued from p. 511.

altitudes only—a miniature dumpy level, fitting on to the same tripod which carries a full-sized azimuth compass, reading to half-degrees.

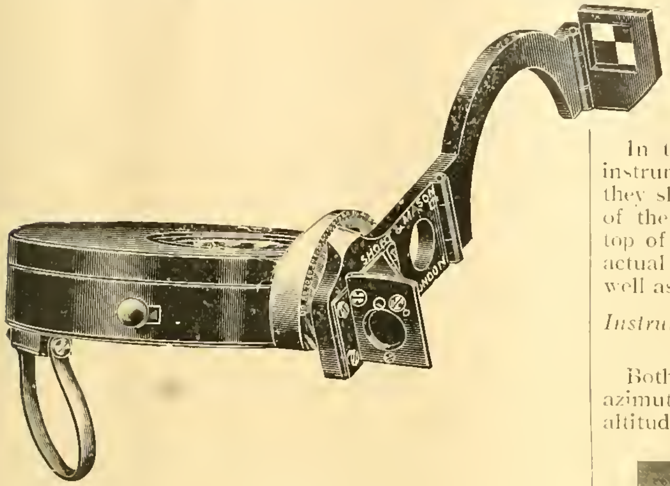


FIG. 16.—Verschoyle's pocket transit, showing the side arm for measurement of altitudes.

Azimuth and altitude are also provided for in the so-called Verschoyle pocket transit. In this the horizontal plane is provided for by adjusting a bubble in a short spirit level.

The altitude arrangement is on the side of an azimuth compass, the graduations of which are read from the side by a right-angled prism, the graduations being cut on a bevelled edge.

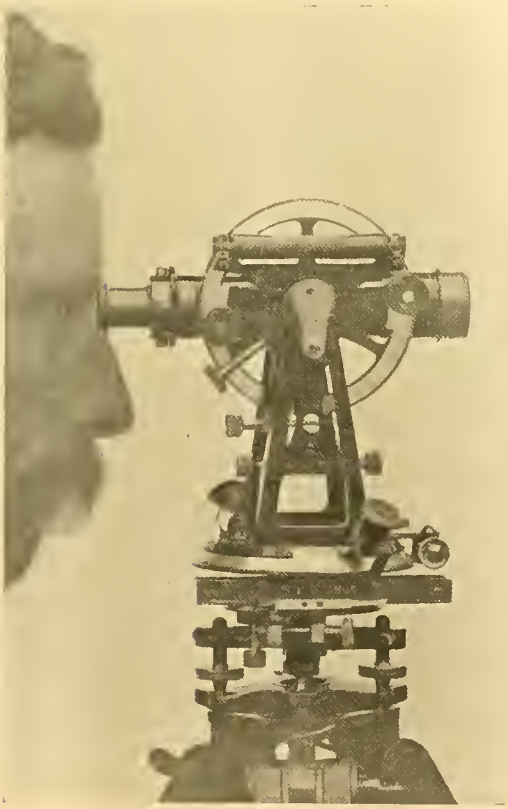

FIG. 17.—Observing an azimuth with a small theodolite.

Observations of magnetic azimuth and altitude can also be made by more complicated instruments, such as theodolites, miners' dials, &c., if, as is generally the case, a magnetic needle is provided for determining the magnetic north point.

The chief point about the theodolite in all its forms is that, whether provided with a needle to give magnetic north or not, observations of sun and stars can be made so that the true or astronomical north can be found.

In the readings of altitude made by any of these instruments, where trees, houses, &c., top the horizon, they should, of course, be neglected, and the elevation of the ground level at that spot taken. Should the top of the azimuth mark (stone, &c.) show above the actual horizon, its elevation should be recorded, as well as that of the horizon.

*Instruments for determining Astronomical Azimuth and Altitude.*

Both for the determination of astronomical or true azimuths directly, and for accurate observations of altitude, a theodolite is essential. It is true, as has been stated, that a theodolite armed with a magnetic needle can provide us with magnetic bearings, but if the best use is to be made of it the needle should be discarded altogether.

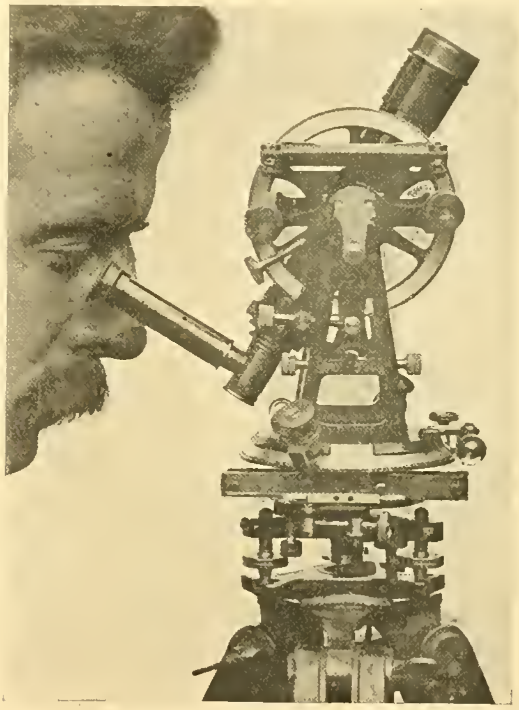

FIG. 18.—Eyepiece attachment to a theodolite to enable observation of the sun, or a star at a high altitude such as Polaris, to be made.

A theodolite is a very complicated instrument, and really little can be learned by a perusal of a description, however long or detailed. The best way of learning how to use it is to get a friend to give you instructions while you, *yourself*, take each part out of its box, set it up, and then proceed to make some observations with it.

In using a theodolite the various alignments required are referred to some fixed point on the horizon, or at all events some distance away, and the angles determined; the true azimuth of the fixed point is then found by observations of the sun or a star.

(1) If only an approximate azimuth is required, the best means of determining it is by fixing the direction of the sun or a star when it has the greatest altitude. This direction, of course, defines the astronomical meridian, as all heavenly bodies cross it when they are at their greatest altitude.

By using stars of both high and low altitudes a greater exactness can be obtained, but, after all, the method only gives a first approximation, as its weakness lies in the very slow change of altitude as the meridian is approached.

(2) A much more accurate method is that of observing the azimuth of a star when at the same altitude east and west of the meridian. If the mean of the two readings given by the azimuth circle be taken, the resulting reading indicates the direction of the meridian.

(3) To find the meridian line by means of the pole star is a simple and accurate method, as a value can be obtained at *any* time at night by a simple altitude, provided the time of observation is known.

Should there not be sufficient time to take the necessary observations, the true bearing of the sun and also some star can be obtained by inspection from Birdwood's azimuth tables.

If we employ the sun in place of a star, its change of declination during the interval between the observations must be taken into account.

It is not alone with regard to azimuth that the results obtained by a theodolite far surpass all others in accuracy, as all magnetic difficulties are overcome, and larger circles give us closer and more accurate readings.

In altitude observations the fact that the observing telescope can be reversed and swung round so that all sources of errors of the horizontal plane of the instrument can be eliminated is a matter of equal importance, for in such work, if accuracy is required, as it should be, one setting and one reading are of little use.

NORMAN LOCKYER.

## THE HORNED DINOSAURS.[1]

FROM time to time mention has been made in the columns of NATURE of contributions to our knowledge of what are perhaps the most wonderful members of a wonderful order, namely, the horned dinosaurs, or Ceratopsia, of the American Upper Cretaceous, the last of such notices relating to Mr. Lull's conclusions to be drawn with regard to the cranial muscles of the typical forms from the study of the skull. In the present sumptuously illustrated volume, which has a melancholy interest as being mainly the work of an exceedingly talented and promising palæontologist who did not live to earn the full reward of his labours, we have a full description of all that is known with regard to the osteology, relationships, and classification of these wondrous reptiles, together with notes and speculations (by Mr. Lull) regarding their distribution, phylogeny, and probable habits and environment.

Restoration of a Horned Dinosaur (Triceratops), with an Iguanodont (Trachodon) in the distance. From Hatcher's "Ceratopsia."

In his preface Mr. Hatcher, we are glad to observe, bore testimony to what we owe to the late Prof. O. C. Marsh in the matter of our knowledge of the Ceratopsia. To a large extent his generosity "made it possible to bring together the collections upon which this volume is based. Nor did his contributions to the subject end here, for, as appears on the title-page, the present memoir was based on his preliminary studies, and although he left no manuscript aside from his

[1] "The Ceratopsia." By J. B. Hatcher. Edited and completed by R. S. Lull. Pp. xxx+300; plates i-lii. (Washington: U.S. Geol. Survey. Monograph xlix., 1907.)

published papers on the Ceratopsia, he provided a fund of information in the shape of finished and unfinished drawings."

Mr. Hatcher considered the horned dinosaurs to be probably an exclusively American group, none of the European dinosaurs tentatively placed therein having any definite claim to such a position. In the case of a Wealden bone, described as a ceratopsian horn, the opinion is expressed that it is really a much weathered ungual phalange of a member of the sauropod group.

Leaving Mr. Hatcher's osteological section, the remainder of this notice may be devoted to brief mention of some of the interesting facts and speculations brought together in Mr. Lull's supplement.

The earliest known Ceratopsia occur in the Judith River beds, but of the ancestors of these latter we have no knowledge, possibly for the reason that they were inhabitants of dry land, instead of, like their successors, frequenters of swamps. The members of the group living at the Laramie epoch exhibit advance over their predecessors in the matter of bodily size, the preponderance of the supraorbital pair of horns over the single nasal one, the fuller development of the wonderful flange-like neck-shield of the skull, and the perfection of a peculiar type of dentition. Several attempts have been made to reproduce the external form of the horned dinosaurs, the most successful, in the opinion of Mr. Lull, being a painting and a statuette by Mr. C. R. Knight of Triceratops, the former of which is copied as a frontispiece to the volume before us, and is herewith reproduced.

That the horned dinosaurs were herbivorous is perfectly manifest; and it is suggested that while the edentulous, and doubtless horny, beak served for cropping succulent leaves and shoots, the teeth in the sides of the jaws chopped the food into short fragments, as they were not adapted for mastication. Swamps seem to have been the home of these rhinoceros-like dinosaurs; and this, it is suggested, may negative the idea that they were exterminated by the attacks of small predaceous mammals, since it has been considered that the latter were arboreal. If, however, mammals are derived from the theriodont reptiles, the theory that all the early forms were arboreal seems to require reconsideration.

Be this as it may, a more probable factor leading to the wane of the Ceratopsia was "changing climatic conditions and a contracting and draining of the swamp and delta regions caused by the orographic upheavals which occurred towards the close of the Cretaceous. The Ceratopsidæ and their nearest allies, the Trachodontidæ, both highly specialised plant-feeders, were unable to adapt themselves to a profoundly changed environment because of this very specialisation, and, as a consequence, perished."

The volume reflects the highest credit on all concerned in its production, and is an admirable example of the modern style of palæontological investigation, so intrinsically different in its picturesque speculation from the long series of dry details which alone formed the contents of works of this nature published a quarter of a century ago. R. L.

## *NOTES.*

The death is announced of M. D. Clos, director of the Jardin des Plantes at Toulouse, and correspondant of the section of botany of the Paris Academy of Sciences.

Prof. L. H. Bailey, of Cornell University, has accepted the chairmanship of the commission appointed by President Roosevelt to report upon the social and economic conditions of agricultural life.

A Reuter message from Berlin announces that the Academy of Sciences there has received a legacy of 30,000,000 marks (1,500,000*l.*), being the entire fortune of a millionaire named Samson, who recently died childless at Brussels.

At Le Mans on Monday, Mr. Wilbur Wright travelled in his flying machine a distance of 48·12 kilometres in 1h. 7m. 11·4s. He afterwards performed a flight lasting 11m. 35·4s., with a passenger, at a speed of nearly one kilometre a minute.

The Graham medal of the Royal Philosophical Society of Glasgow (awarded for original research in any branch of chemical science) is now open to competition. All information respecting the conditions of the award may be obtained from the secretary of the society.

The quinquennial Riberi prize, of the value of 800*l.*, according to the *Athenæum*, has been awarded by the Academy of Turin to Prof. Bosco, of Turin, for his discovery of biological reaction, *i.e.* of a peculiar growth of mould on substances containing arsenic, tellurium, or selenium.

The eighth International Congress of Hydrology, Climatology, Geology, and Physical Therapeutics is to be held at Algiers on April 4 to 10 next. All papers to be read at the meeting should be sent by, at latest, January 31. Full particulars of the congress can be obtained from M. Raynaud, 7 Place de la République, Algiers.

Dr. Sven Hedin, in delivering a private lecture at Simla on his discoveries in Tibet, stated that although little is left in that country in the way of geographical discovery, in geology much remains to be done. Dr. Hedin is of opinion that from two to three years will be required to work up the mass of information collected by him relating to tracts hitherto unknown to Europeans.

The Dove Marine Laboratory at Cullercoats was opened on Tuesday by the Duke of Northumberland. A polished granite tablet near the entrance bears the inscription:—"Erected A.D. 1908 by Wilfred H. Hudleston, M.A., F.R.S., for the furtherance of Marine Biology and as a Memorial of his Ancestress Eleanor Dove." The new building, which stands on the site of the old baths, contains an aquarium 30 feet by 23 feet, and there are eleven fish tanks. There is also a private aquarium, and provision is made in thirty-six tanks for the storing of materials for experimental work. A concrete tank holding 15,000 gallons of salt water will give a continual flow through the various tanks. The laboratory is in connection with Armstrong College, Newcastle-on-Tyne.

A return issued by the Government of India shows that the total mortality amongst human beings reported to be due to snake-bite was 21,419 in 1907. The treatment of snake-bite by incision and application of permanganate of potash, as recommended by Sir Lauder Brunton (see Nature, June 9, 1904, p. 141), continues, and lancets are distributed for this purpose, but the value of the results is discounted by the absence of identification of the snake that inflicted the bite. In Burmah nearly all the deaths occurred in paddy tracts where Russell's viper is particularly prevalent. Steps are being taken in that province to ensure a wide distribution of the Brunton lancets. It is reported that in the Pegu district six men and one buffalo bitten by Russell's vipers were operated on by headmen to whom lancets had been issued, and that all recovered but one man, who was unconscious before being treated. Eight cases are reported from the United Provinces of the successful use of Dr. Calmette's anti-venene. In two of these cases the permanganate of potash treatment was also employed.

The new session of the Royal Geographical Society will open on November 2, when Mr. D. G. Hogarth will give the first of a series of papers on the unexplored world, his subject being Western Asia. This will be followed by the undermentioned communications:—Some aspects of the River Paranà and its watershed, by Mr. W. S. Barclay; an account of his investigations on the Panama Canal, by Dr. Vaughan Cornish; a paper on his two expeditions into Bhutan, by Mr. J. Claude White; the Western Pacific, by Sir E. F. im Thurn; on a recent journey in North Central Arabia, by Captain S. S. Butler; South America and its Antarctic relations, by Prof. G. F. Scott Elliot; earthquakes and geography, by Mr. R. D. Oldham; and a paper on Australia, by Prof. J. W. Gregory, being the second of a series of lectures on the geographical conditions affecting the development of the British Empire; while Prof. W. M. Davis, of Harvard University, is to lecture in March on the Colorado Canyon and some of its lessons. Lectures may also be expected from Dr. Sven Hedin, Dr. M. A. Stein, Col. R. G. T. Bright (on the results of his expedition for the delimitation of the boundary between Uganda and the Congo Free State in the region of Mount Ruwenzori, Lakes Albert and Albert Edward, and the Semliki Valley), Lieut. A. Trolle (on the Danish expedition to north-east Greenland). On December 14 will be commemorated the jubilee of Speke's discovery of the Victoria Nyanza, and on that occasion Sir William Garstin is to read a paper on fifty years of Nile exploration and some of its results.

Mr. George Nicholson, formerly curator of the Royal Gardens, Kew, whose death occurred on September 20 at Richmond, Surrey, as announced last week, was the son of a Ripon nurseryman. He was born in 1847, and after gaining experience in English and French nurseries was appointed a member of the Kew staff in 1873 as assistant to the curator, the second John Smith. He succeeded Smith as curator in 1886, and remained in this office until 1901, when he retired through enfeebled health. Nicholson was a prolific writer on horticultural matters, and his monographs of Quercus and Acer, published in the *Gardeners' Chronicle*, are testimonies to his conscientious and capable work. His memory, however, will live in the "Illustrated Dictionary of Gardening," published in four volumes, which he edited more than twenty years ago. Of all modern books, Nicholson's "Dictionary" has exerted the most influence in spreading horticultural knowledge. Nicholson was a first-rate gardener, an enthusiastic and critical British botanist, and a man who had studied chemistry very closely. He was greatly interested in natural history, particularly in insects, and contributed many papers to the *Kew Bulletin* on the fauna of the Kew Gardens. Nicholson was a Veitch medallist, and was amongst the first sixty who were awarded the medal of honour in horticulture by the Royal Horticultural Society in 1897. He was also an elected associate of the Linnean Society. It may be added that in 1901, when his retirement from the curatorship took place, Nicholson presented his excellent collection of British plants to the Aberdeen University.

No. 10 of vol. iv. of Circulars and Agricultural Journal of the Royal Botanic Gardens, Ceylon, is devoted to an account of the life-history and ravages of white ants, which are closely connected with botany through the cultivation by these insects of "fungus-gardens."

No. 10 of the "Fauna of New England" (Papers Boston Soc. Nat. Hist., vol. vii.) is devoted to the Pseudoscorpionida, Acarina, &c. New genera and species of local Thysanoptera form the subject of article 2, vol. viii., of the Bulletin of the Illinois State Laboratory of Natural History.

We have to acknowledge the receipt of a copy of a suggestive historical address (published by G. Fischer, of Jena) entitled "Alte und Neue Naturgeschichte," delivered on July 30 by Prof. Ernst Haeckel at the meeting to celebrate the opening of a "Phyletische Museum" at Jena on the occasion of the 350th anniversary of the University.

Japanese locusts, by Messrs. S. Matsumura and T. Shiraki, and the earlier stages in the development of the vascular system of Ammocœtes, by Mr. S. Halta, form the subjects of vol. iii., part i., of the Journal of the College of Agriculture of Tohoku Imperial University, Sapporo, Japan.

A preliminary catalogue of the birds of Missouri, by Mr. Otto Widmann, forms the subject of vol. xvii., No. 1, of the Transactions of the Academy of Science of St. Louis. The subject is treated in considerable detail, with a preliminary account of the physiography of the district, but is, of course, mainly of local interest.

The report of the Natal meeting (1907) of the South African Association has just reached us. In issuing the volume, the editorial committee regrets that it has been compelled to reduce many of the contributions to an abstract or a mere title, the reason being the lowness of the association's funds occasioned by the non-payment of their subscriptions by many of the members.

The annual report of the acting superintendent of the Indian Museum, Industrial Section, Calcutta, for the year 1907–8 has reached us, from which we learn that the work of analysing samples has increased from about 100 samples per annum in 1897 to 340 in the period under review, which analyses are distributed as under:—natural exudations, 89; oils and oil-seeds, 66; dyes and tans, 35; fibres, 55; medicinal products, 25; food-stuffs, 58; minerals, 12.

A fine example of an adult female *Mesoplodon bidens*, Sowerby, fully 16 feet long, was stranded on the West Sands, St. Andrews, on May 28. As one flipper seemed to be paralysed, it is possible that it had been struck by a spent shot or had collided with the ram or other part of a vessel of the fleet which was then in St. Andrews Bay. The specimen was at once secured by Dr. Tosh for the University Museum. Teeth were only visible in the mandible after maceration. The skeleton will be described by Sir William Turner.

The valuable deodar-forests of the Simla area are suffering from a severe attack of four bark-boring beetles, two of which belong to the genus Scolytus, while a third, *Polygraphus minor*, is a species usually restricting its attentions to the blue pine, and the fourth is a buprestid. The last-named is new to Mr. E. P. Stebbing, who has contributed an illustrated account of the visitation to the Indian Forest Zoology Series.

In the chief article in the August issue (part iv.) of the Journal of the Royal Microscopical Society, Mr. W. Wesché discusses the microscope as an aid to the study of biology in entomology, with special reference to the food of insects. According to the author, in the case of the large majority of insects the life-histories still remain unstudied, and the habits of many well-known species are based on conjecture. Details of the methods of work followed and some of the results obtained are given in the course of the paper.

The littoral holothurians collected by the survey-ship *Investigator* form the subject of a memoir of Messrs. R. Koehler and C. Vaney in "Echinoderma of the Indian Museum." Out of forty-one species collected, fifteen are described as new. In the second number of Memoirs of the Indian Museum Captain R. E. Lloyd describes the anatomy of the huge phyllopod crustacean *Bathynomus giganteus*, of which the first known example was obtained in 1878 by the survey-ship *Blake*. The species is compared with the American representative of the genus, from which it is shown to differ in the number of basal plates.

To vol. ii., part i., of the Records of the Indian Museum Captain R. E. Lloyd contributes a paper on variation in an Indian species of the marine crustacean genus Squilla. The variation occurs in the number of "teeth" borne by the raptorial claw, and occurs in one particular race (or ? species) inhabiting a certain region of the Indian seas, in apparently deep water. The number of teeth may be as many as fifteen or eighteen, whereas the normal number is six or seven. In the opinion of the author, the facts in this case do not seem to be in favour of the "theory of gradual change" in organisms, and are put on record as a contribution to the study of animal variation available for comparison with other cases of a like nature.

The Cretaceous fishes of Ceara, in Brazil, form the subject of a paper by Messrs. D. S. Jordan and J. C. Branner in vol. v., part i., of the quarterly issue of Smithsonian Miscellaneous Collections. The existence of fossil fishes in the Cretaceous deposits of this district has been known since the year 1841, when a collection was brought home by Mr. G. Gardner and submitted to Prof. L. Agassiz, by whom some were named and described. Since that date they have formed the subject of several papers, among these one by Dr. Smith Woodward in the Zoological Society's Proceedings for 1887 (quoted more than once in the article before us without any reference to the volume). In addition to the forms recognised by previous writers, Messrs. Jordan and Branner describe a new genus and species of Leptolepididæ, under the name of *Tharrkias araripis*, and likewise three other new species, referable to as many genera.

An investigation into the germinative capacity of seeds of *Hevea brasiliensis*, carried out in Ceylon by Messrs. H. F. Macmillan and T. Petch, yielded the very definite result that in a few weeks the seeds lose their power of germinating. Seeds from untapped trees failed to germinate after being kept for three or four weeks. Seeds from trees that had been tapped for rubber showed a higher percentage in germination, and somewhat better keeping properties; otherwise they were smaller than the seeds from untapped trees, and would presumably yield less oil if they were crushed or extracted for that purpose. The experiments are described in the circulars (vol. iv., No. 11) issued from the Royal Botanic Gardens, Ceylon.

Botanists who are interested in the "Kryptogamen Flora von Schlesien," originally edited by Dr. F. Cohn, will be glad to know that a final part, consisting of an index to the fungi, has just been issued. Dr. J. Schroeter undertook the portion dealing with the fungi, but died shortly before the last descriptive part was published. It was then intended to incorporate some of his notes in the next part; this project was, however, abandoned, and the index was compiled by Dr. A. Lingelsheim in its present form. Apart from the rest of the work, the index is useful, as it provides a list of host plants, cryptogamic as well as phanerogamic, upon which the fungi have been taken.

The Rev. G. Henslow contributes one of his interesting historical accounts in connection with the cabbage group of plants to the new volume (xxxiv.) of the Royal Horticultural Society. It is remarked that Cato sang the praises of the cabbage and distinguished three kinds, while Pliny recognised six varieties. The author endeavours to trace modern races from the figures of the coleworts, forms of *Brassica oleracea*, inscribed in Gerard's Herbal dated 1597. Gerard refers the stock generally to *Brassica marina anglica* or English sea colewort. The kales are nearest to the suggested original type from which the true cabbage is derived by shedding of the lower stem leaves and aggregation of the leaves at the top; special development of buds in the lower leaves has led to the variety now represented by Brussels sprouts.

We have been favoured with the report (No. 16) of the Danish Biological Station to the Board of Agriculture, in which Dr. C. H. Ostenfeld presents an account of the growth and distribution of the wrack-grass, *Zostera marina*, in Danish waters. The conditions necessary for the growth of Zostera are a salinity varying from ½ per cent. to 3 per cent., and a sufficiency of light such as can be obtained to a depth of six fathoms. The most luxurious development is attained on muddy or sandy bottoms in the sheltered waters of the fjords. The author subscribes to the opinion that the Zostera vegetation provides an important breeding ground for the nourishment of food-fishes.

It is fitting that an early volume (part ii.) of the newly established *Indian Forest Records*, published by the Government of India, should be devoted to the consideration of compiling forest statistics with reference to the growth and increment of timber trees. Mr. A. M. F. Caccia, the officer in charge of forest working plans at the Imperial Research Institute, Dehra Dun, has collated existing data for the "sal" tree, *Shorea robusta*, to indicate how incomplete are present records, and what additional measurements are necessary to make the statistics as full as those compiled by forest research bureaux in Europe. With regard to the requirements of the "sal" plant, it is noted that it grows at elevations ranging from 150 feet to 6000 feet, where the annual rainfall varies between 40 inches and 180 inches, and demands, in addition, a loose, well-drained soil.

Notification is given by the Board of Agriculture and Fisheries that the potato disease known as wart disease, cauliflower disease, or black scab, has been scheduled under the Destructive Insects and Pests Order of 1908. All occupiers of land on which the disease appears have to report the fact to the Board, from the secretary of which a leaflet describing the disease and suggesting preventive measures can be obtained on application. The Board of Agriculture and Fisheries has also issued a leaflet respecting grain weevils, in which brief descriptions are given of the nature of the harm done, the life-history and habits of the insect and its grub, and the known remedial measures. Copies can be obtained from the secretary.

THE Royal Commission on Sewage Disposal has recently issued its fifth report, and deals mainly with the relative merits of the various methods which are available for the purification of the sewage of towns. The work contains a number of appendices, and the general conclusion of the commissioners on the main subject is as follows:—"We are satisfied that it is practicable to purify the sewage of towns to any degree required, either by land treatment or by artificial filters, and that there is no essential difference between the two processes, for in each case the purification, so far as it is not mechanical, is chiefly effected by means of micro-organisms. The two main questions, therefore, to be considered in the case of a town proposing to adopt a system of sewage purification are, first, what degree of purification is required in the circumstances of that town and of the river or stream into which its liquid refuse is to be discharged; and, second, how the degree of purification can, in the particular case, be most economically obtained. The choice of a scheme must depend on a number of considerations which will be discussed later, but we may here state that we know of no case where the admixture of trade refuse with the sewage makes it impracticable to purify the sewage either upon land or by means of artificial processes, although in certain extreme cases special processes of preliminary treatment may be necessary."

IN the *Popular Science Monthly* for September, Mr. N. H. Winchell discusses the ethnology and traditions of the American Indian tribes, and specially of the so-called "mound-builders" of Minnesota. Modern research has established the enormous antiquity of these tribes in their present habitat. Thus the great variety of dialects, none of which can be connected with those of Europe or Asia, indicates either that the present population is the result of a number of successive migrations, or, which seems more probable, is the outcome of their long occupation of American soil. One fact is quite certain, that the mound-builders were the ancestors of some of the existing tribes. From a mass of confused legend it may be gathered that the practice of mound-building was confined to two stocks—the Algonquian and the Siouan—the former spreading over the north-eastern part of the United States and Canada, but with no representatives on the south-east Atlantic coast, the latter mainly confined to the great plains west of the Mississippi, this river apparently forming the boundary line between these two stocks. Whatever may be the value of Mr. Winchell's speculations regarding the post-Glacial movements of these races, he seems to be right as regards the sequence of tribal occupation in Minnesota. It begins with that of the Algonquian stock, a small area to the south-west being also held by the Ohio mound-builders. These were followed by Sioux fugitives from Ohio, to whom the majority of the mounds are attributed, to be followed, again, by an Ojibwa Algonquian incursion from the region of Lake Superior, these people dividing the State with the Sioux. This was the condition of things when the European appeared upon the stage. The value of this contribution to American ethnology would be greater if the essay had been accompanied by fuller reference to the authorities upon which it is based.

THE position of meteorology at the recent meeting of the British Association is again referred to in the September number of *Symons's Meteorological Magazine* (see NATURE, vol. lxxvi., p. 448). The writer states that from a meteorological point of view the meeting was the best since that of Southport in 1903, but, despite the efforts of the president of Section A (Dr. W. N. Shaw), no meeting ever showed more plainly the inferior position of meteorology as compared with other observational sciences. In the subsection of cosmical physics, meteorology and astronomy were mixed together in a way that was satisfactory to neither, and it was sometimes impossible to know at what hour the subsections would meet. The writer considers that a radical reform is necessary in the constitution of the association if it is to regain the high position it formerly held, and that meteorology will not be properly respected, or its true position understood, unless it is made at least a separate subsection, with a chairman of its own, and the hour of commencement of the meetings definitely announced.

WE have received from M. Charles Féry a pamphlet of 100 pages describing his exhibit of scientific apparatus at the Franco-British Exhibition. It is not by any means a maker's catalogue, but appears to consist of a collection of reprints of the original descriptions of the apparatus in the Proceedings of the Académie des Sciences, Société française de Physique, &c., some of which have been noticed in these columns. It will prove useful to those who are concerned with the scientific as distinct from the mere mechanical use of the apparatus, and it raises the question whether the publication of pamphlets of this type might not with advantage be taken up more extensively by instrument makers in this country.

IN order to assist makers of volumetric apparatus in establishing standards and perfecting methods of construction, the Bureau of Standards at Washington has for the last four years issued a circular containing specifications for and regulations for testing such apparatus. The third edition of this circular is embodied in an article in the May issue of the Bulletin of the bureau, on the testing of glass volumetric apparatus, by Messrs. N. S. Osborne and B. H. Veazey. In it the various specifications and rules for manipulation of the apparatus are discussed, and much information is given which bears directly on the construction, use, and testing of volumetric apparatus in general. As an example of the degree of accuracy expected, we note that for a litre flask the error should not exceed 0·3 cubic centimetre.

IN an article in the *Physikalische Zeitschrift* for September 1, Prof. H. A. Lorentz expresses with some reserve the belief that a satisfactory deduction of the law of radiation of a black body based on the electron theory, without the introduction of the so-called law of equipartition of energy, is impossible without serious modifications of the fundamental ideas of the theory itself. We must therefore accept Prof. Planck's theory of radiation as the only one tenable at the present time, and must wait for an explanation of the reason why the resonators of the theory do not appear to come within the province of the statistical mechanics of Gibbs. Prof. Lorentz points out a further difficulty of the electron theory of conduction of heat and electricity in metals as developed by Drude. According to this theory the oscillations of the free electrons within the metal account for the radiation of long waves by the metal, but are incapable of giving the short-wave radiation correctly, and no satisfactory explanation of this inconsistency has yet been given.

AN interesting contribution to the study of differences in the physiological behaviour of the right- and left-handed forms of optically active substances is contained in a short note by G. Bruni in the *Gazzetta Chimica Italiana* (vol. xxxviii., ii., p. 1). It is well known that the lower organisms, such as moulds, often show a striking preference for one of the two forms, assimilating or destroying it, whilst the other form is rejected. Whilst the same seems to be true in the case of the higher animals, the experiments as yet made are somewhat uncertain. In the present paper Mr. Bruni deals with the differences shown by the right- and left-handed forms of camphor. The latter was found in a large number of experiments to be about thirteen times as poisonous as the former when injected into the circulation of rabbits or guinea-pigs. The lævo form also differs strikingly from the dextro form in being practically tasteless; a somewhat similar difference has already been recorded for the two asparagines, the dextro form being sweet, the lævo form tasteless.

THE *Revue scientifique* for September 10 contains a lecture delivered by Sir William Ramsay to the French Association for the Advancement of Science during the meeting at Clermont-Ferrand. In this lecture a full account of the discovery of the inactive gases of the air is given in popular language. The relation of the radium emanation to these gases is also dealt with, allusion being made to the production of helium and neon from the emanation. A review of the periodic table shows that in two of the groups (6 and 7) inactive elements of the argon group with higher atomic weights than xenon may be expected, and details are given of the recent attempts made by Sir William Ramsay, in conjunction with Prof. Moore, to isolate these two elements. The less volatile residues arising from the fractional distillation of more than 100 tons of liquid air were placed at the disposal of the lecturer by M. Claude. Oxygen, nitrogen, hydrogen, hydrocarbons, carbon monoxide, and water vapour were removed in succession by the usual means, and the residue of inert gases cooled to $-185°$ C., and submitted to systematic fractionation. The result of this series of operations was the relatively enormous quantity of 300 c.c. of xenon. This was liquefied at $-130°$ C., and again submitted to a methodical fractionation. No trace of any foreign substance could be detected in this xenon, the spectrum of the last third of a cubic centimetre being absolutely identical with that of the bulk. This failure to isolate these heavy gaseous elements from the air may be due to their lack of stability; they may constitute the emanations of radium, thorium, and actinium.

FROM Messrs. Carl Zeiss, Jena, we have received a copy of the third edition of their "Astro. 8" catalogue, a handsomely illustrated volume which should be seen by all those desiring to purchase any kind of instrument or fitting for astronomical use. The present edition, which can be obtained gratis and post-free upon application, has been prepared with the view of meeting all the likely requirements of the scientific amateur astronomer, and includes telescopes and accessories up to an objective clear aperture of $7\frac{7}{8}$ inches (200 mm.); for larger or special instruments the firm furnishes special estimates. There are several new constructions appearing for the first time in this edition. Among these we notice an ingenious relief system of the hour and declination axes, a changing appliance permitting any accessory to be fitted instantly to the breach of the telescope tube without screwing, and a new sun prism devised by Father A. Colzi, and consisting of a Herschel reflector and a Pickering double-prism; the second prism contains a fluid the depth of colour of which may be chosen to give an agreeable brightness of image. The astro-Tessar and U.V. objectives are also illustrated and quoted, and the catalogue concludes with illustrated specifications of variously sized domes. The London address of the firm is 29 Margaret Street, Regent Street, W.

MR. JOHN MURRAY has published a cheap edition (price 2*s*. 6*d*. net) in cloth of Darwin's "Insectivorous Plants."

MESSRS. JOHN WHELDON AND CO., of Great Queen Street, W.C., have just issued a useful catalogue of books dealing with physical sciences.

A NEW edition of their useful illustrated price-list of balances, scales and weights has been issued by Messrs. F. E. Becker and Co., of Hatton Wall, London, E.C. Every form of weighing instrument seems to be represented, and the catalogue includes particulars of a great variety of weights and accessories for use with balances.

MESSRS. JOHN J. GRIFFIN AND SONS, LTD., are prepared to send post free to chemists, teachers of chemistry and others applying for it, a very complete price-list of organic and inorganic chemicals and volumetric solutions manufactured by Mr. C. A. F. Kahlbaum, of Berlin. All the chemical preparations described are included in Messrs. Griffins' London stock.

IN the Journal of the Franklin Institute (vol. clxvi., No. 2) Mr. J. S. Hepburn gives the results of tests of the numerous modifications of the Kjeldahl method for the quantitative determination of nitrogen. The nitrogen content of antipyrin was determined, but in no case was the theoretical percentage of nitrogen obtained. The absolute method of Dumas, however, may be applied to antipyrin with success.

THE report of the Felsted School Scientific Society for the year 1907 provides abundant evidence that good work continues to be done in this school, by the masters and others, to encourage and maintain among the older boys a practical interest in the study of science. The work accomplished during the year is chronicled under botanical, chemical, geographical, and zoological sections. The report of the geographical section includes a fairly complete weather record for the year with which the report deals.

A NEW volume of "The Fauna of British India" has just been published by Messrs. Taylor and Francis. The volume deals with the families Testacellidæ and Zonitidæ of the Indian land mollusca. The late Dr. W. T. Blanford, F.R.S., left a short manuscript in which the shells were dealt with, chiefly from the conchological side, and this formed the foundation of the volume. Lieut.-Colonel Godwin-Austen, F.R.S., who has been responsible for the malacological part, and whose name appears with that of Dr. Blanford upon the title-page, contributes an introduction which should be the means of creating interest in the two important families of Indian land-shells described.

## OUR ASTRONOMICAL COLUMN.

COMET MOREHOUSE.—The following set of elements and an ephemeris for comet 1908*c* appear in No. 138 of the Lick Observatory Bulletins. They have been computed by Messrs. Einarsson and Meyer, of the Berkeley Astronomical Department, from observations made at the Yerkes and Lick observatories, and subsequent observations show a satisfactory agreement between the observed and calculated positions. It will be noted that, according to these elements, perihelion will not take place until January 5, whilst the computed increase in brightness is not so rapid as given previously.

*Elements.*

$$T = 1909 \text{ January } 5{\cdot}702 \text{ G.M.T.}$$

$$\left.\begin{array}{l}\omega = 152° \;\; 4'{\cdot}0 \\ \Omega = \;\;90° \;\; 20'{\cdot}5 \\ i = 135° \;\; 56'{\cdot}2\end{array}\right\} 1908{\cdot}0$$

$$q = 1{\cdot}1680$$

*Ephemeris for Greenwich Mean Midnight.*

| 1908 | | α (true) h. m. | | δ (true) ° ′ | | log Δ | | Brightness |
|---|---|---|---|---|---|---|---|---|
| Oct. 1·5 | ... | 21 32·4 | ... | +72 58·4 | ... | 0·1249 | ... | 2·7 |
| 2·5 | ... | 21 18·8 | ... | +72 5·0 | | | | |
| 3·5 | ... | 21 6·4 | ... | +71 6·9 | ... | 0·1170 | ... | 2·9 |

LARGE GROUP OF SUN-SPOTS.—The large group of sun-spots referred to in these columns on August 13, and again on September 10, has again been brought into view by the sun's rotation, this making the third rotation during which the same group has been seen. Its persistent activity is evidenced by the fact that it is once more visible to the naked eye, although the separate spots seem to be somewhat smaller and more scattered.

THE ORBIT OF ζ CANCRI C.—The measures of ζ Cancri made since 1756 are brought together by Prof. Doberck in No. 4273 of the *Astronomische Nachrichten* (September 14), and are supplemented by a few brief notes concerning the orbit of the smaller component (C) of the primary pair.

It will be remembered that this system was the first for which the existence of three components was established, the duplicate character of the larger star of the primary pair being discovered by Herschel in 1781. Subsequent observations showed that the motion of C is very irregular, and led to the suspicion that this star is accompanied by a dark companion. Independent evidence of the existence of this invisible companion is deduced by Prof. Doberck from measures made by Profs. Burnham and Barnard between 1891 and 1905.

He also finds that the star C moves round the centre of gravity of C and D (the dark body) in a circle of 0″·158 radius, the period being 17·43 years. Assuming the combined mass of A and B to be equal to that of the sun, it follows that the relative masses of A, B, C, and D are 0·5, 0·5, 0·62, and 0·43 respectively.

SEARCH-EPHEMERIS FOR COMET TEMPEL$_3$-SWIFT.—A continuation of the ephemeris, published by M. E. Maubant in No. 4269 of the *Astronomische Nachrichten*, for the comet discovered by Tempel in 1869 is given below:—

*Ephemeris 12h. M.T. Paris.*

| 1908 | | α h. m. | | δ ° ′ | | log r | | log Δ |
|---|---|---|---|---|---|---|---|---|
| Sept. 30 | ... | 7 3·4 | ... | +31 3·5 | ... | 0·0619 | ... | 9·8396 |
| Oct. 4 | ... | 7 20·9 | .. | +30 16·9 | ... | 0·0622 | ... | 9·8411 |
| 8 | ... | 7 37·4 | ... | +29 23·7 | ... | 0·0634 | ... | 9·8431 |
| 12 | ... | 7 52·8 | ... | +28 25·4 | ... | 0·0655 | ... | 9·8454 |
| 16 | ... | 8 7·2 | ... | +27 23·4 | ... | 0·0683 | ... | 9·8478 |

Three ephemerides are given, that from which the above is taken being computed for the mean date (September 30·88) for perihelion passage. According to the above, the comet should be some 2° S. of Castor on October 6, and about 45′ N. of Pollux on October 9.

THE MANORA OBSERVATORY.—According to a note published in No. 400 of the *Observatory* (p. 362, September) the Manora Observatory, the instruments of which were recently announced for sale, has been purchased by an anonymous person, who invites observers of all nations to observe with the equatorial.

A NEBULOUS FIELD IN TAURUS.—In the September number of the *Bulletin de la Société astronomique de France* (p. 400) Prof. Barnard has an interesting discussion of an extensive nebulosity, which he has photographed, in the constellation Taurus.

A splendid reproduction accompanies the note, and shows the peculiarities discussed. These consist of long dark lanes, in an otherwise nebulous region crowded with stars, apparently devoid of both stars and nebular matter, and Prof. Barnard discusses the hypothesis that their appearance is caused by the interposition of absorbing material between the background of nebula and stars and the earth. He finds this explanation difficult to embrace, but so far is unable to offer a more reasonable one. The field covered by the photograph lies between R.A. 4h. 0m. to 4h. 34m., and dec. +24° to +28°·5.

## THE ISOTHERMAL LAYER OF THE ATMOSPHERE.

THE important discussion of which we give here a detailed account was organised by the committee of Section A of the British Association, and took place at the recent meeting.

It was intended that M. L. Teisserenc de Bort should open the discussion, but he was unable to be present, and sent the following communication:—

Permit me to open the discussion on the isothermal layer and the inversions of temperature which are found there by recalling in a few words the results obtained during the past twelve years. Our experiments at Trappes have shown, in the first place, that the temperature ceased to diminish at a certain height after having passed through a point of maximum rate of decrease about 3000 metres lower down.

The altitude at which the diminution ceases changes with the character of the weather; it may descend as low as 8 kilometres at Paris during a cyclone, while it rises as high as 13 or 14 kilometres in high-pressure areas and in front of large cyclones.

I indicated these peculiarities for the first time in October, 1901, in a communication to the Luftschiffart Verein at Berlin, then in a communication to the Meteorological Society of France in March, 1902, and I developed these conclusions in a note to the Académie des Sciences in April, 1902.

A short time after, in the early part of May, 1902, Prof. Assmann showed from the ascents of six rubber balloons that not only was there a cessation of the decrease of temperature, but also an inversion. This inversion had also been very marked in the first ascents by Hermite and Besançon, but Prof. Assmann sought to explain it as being due to the effect of solar radiation on the thermometer, while the ventilation produced by the rapid ascent of the balloon showed that it could not be referred to such an error in the thermometer record.

Having once demonstrated the existence of this isothermal layer for places in the neighbourhood of Paris, we sought to find the evidence of it in other regions in order to show that it was a general phenomenon. Ascents made by us and our assistants in the winter of 1900–1, by M. de Quervain in Russia, by Mr. Eggenberger at Bath in England in 1902, have made it evident that the phenomenon was a general one. On referring to the results of the international ascents made in different countries, it is seen that the cessation of the temperature decrease is found in the case of all the balloons sent up, and that it is impossible to refer it to insufficient ventilation, since the phenomenon was well marked in ascents made during the night. Since this time, ascents made on board the *Princesse Alice* by Prof. Hergesell in 1905 have furnished evidence of the existence of the layer near the Azores; ascents made in the United States by Mr. A. L. Rotch have furnished evidence of its existence there with the peculiarities I have indicated, *i.e.* high up over high-pressure areas and low down over low-pressure areas.

The expeditions of the *Otaria*, organised in conjunction with my friend Mr. Rotch, have proved the existence of the zone in the tropics, and have shown that it is further from the earth near the equatorial regions where the trade winds meet.

Finally, the ascents made at the end of the winters of 1907 and 1908 by the French-Swedish expedition organised by the Observatory of Trappes, with the support of Prof. Hildebrandson, have shown that near the Arctic Circle, at Kiruna, the layer exists and possesses general characteristics analogous with those found in these regions.

The results of series of daily ascents for eight, ten, or more days in succession in February, 1901, March, 1903, and May, 1904, have proved that the change of altitude of the point where the temperature ceases to fall is accompanied by changes of temperature of 10° C., 15° C., 20° C. in an interval of a day or two at heights between 9 and 13 kilometres, variations great enough to be felt near the surface during the same time.

Thus the equalisation of temperature in the course of the year, which had been supposed to be nearly complete at 8 or 9 kilometres altitude, does not exist, but, on the contrary, sudden changes of temperature occur with the passage of cyclones and anticyclones which would furnish to an observer in those regions the chief evidence of the changes occurring at the surface.

*Causes of the Isothermal Layer.*—The summary of the observed phenomena has led me to this conclusion, that the cessation of the temperature diminution is due to the fact that there is at these heights no considerable vertical convection.

The fact that one meets with layers of air thousands of metres thick where the temperature increases and decreases rapidly, and others where it is stationary, is incompatible with the existence of motion of the air accompanied by pressure variations, which always tend to produce a vertical temperature gradient more or less near that for the adiabatic state. It does not follow that the movement in the isothermal layer must be horizontal, but that it takes place along the isobars without crossing these surfaces nearly in the manner in which a body rolls on an inclined plane.

These ideas have been developed in several communications, in particular at the Conférence d'Aérostation scientifique at St. Petersburg in September, 1904.

Dr. Shaw, in the absence of M. L. Teisserenc de Bort, opened the discussion. He explained what was the main feature of the phenomenon, and showed how it had been corroborated by *ballons-sondes* ascents made in England. The temperature of the air decreases in the lower layers on the average at 5° C. or 6° C. per kilometre up to a height of about 10 kilometres. Above this height the temperature ceases to fall rapidly and falls very slowly indeed, or remains constant or in some cases increases. It had been suggested that the phenomenon might be due to a change in the composition of the air at great heights. M. L. Teisserenc de Bort had succeeded in sending up balloons carrying vacuum tubes, which were opened and re-sealed electrically at a height of 14 kilometres. The samples of air so obtained were examined spectroscopically, and the examination showed that there was no change in the composition of the air sufficient to account for the cessation of temperature diminution.

Mr. Rotch said the only *ballons-sondes* which have been sent up in America were those dispatched by him. Since 1904 seventy-six rubber balloons have been launched from St. Louis, and all but one have been recovered. The majority of those which rose higher than eight miles (12,870 metres) entered the stratum of relatively high temperature.

All the ascents occurred after sunset, so that there can be no question as to the effect of solar radiation. The instruments used were of M. Teisserenc de Bort's construction, and were verified for low pressures and temperatures before and after the ascents. The warm stratum, which was not isothermal, but became warmer with increased height, was at its lowest level in summer, having a mean minimum temperature of $-54°·6$ C. at 12,000 metres. During the autumn of 1907 the warm stratum of temperature was penetrated eight times, the mean minimum temperature of $-60°·5$ C. occurring at 12,370 metres.

The changes in the level of the minimum temperature from day to day were large. Thus the minimum of $-67°·1$ C. at a height of 14,500 metres, on October 8, was followed two days later by a descent of the minimum of $-62°·2$ C. to 12,000 metres. In the first case, the temperature at the highest point reached, viz. 16,500 metres, was $-58°·1$ C., and in the second case, when 15,000 metres was attained, $-56°·0$ C. On November 6 the minimum temperature of $-52°·2$ C. occurred at 9700 metres, but the place of occurrence of the minimum of $-63°·1$ C. had risen to 14,250 metres on November 8. The temperatures at the highest points reached were $-50°·5$ C. at 10,000 metres and $-60°·2$ C. at 15,380 metres respectively.

These observations, made near latitude 35° N., show the warm stratum to be at a distinctly higher level than in northern Europe, whereas the results obtained by the expedition sent jointly by M. Teisserenc de Bort and the author to explore the atmosphere over the tropical Atlantic in 1906–7 show that it was there considerably higher. In fact, the observations obtained over the equator up to 15,000 metres show no reversal of temperature, and a lower temperature than exists at a corresponding height in northern latitudes.

Mr. Cave said that during the last week in July he was able, by means of theodolites, to follow four balloons into the isothermal layer. From these observations it appeared that the wind velocity increased to a maximum just below the isothermal zone, and decreased rapidly above. The wind velocities were very high, and most of the balloons went out to sea; one, sent up on July 28, was recovered. From the record of the meteorograph it appears that the isothermal layer was entered at 11,500 metres; the theodolite observations indicated that this was the height of the maximum wind velocity; above this the velocity dropped to eight miles per hour at 13,000 metres.

Mr. W. H. Dines said that he knew there had been some doubt expressed about the existence of the isothermal layer, and possibly there were still some who thought that the results obtained were due to instrumental errors. Such a view was now quite untenable, for about seventy ascents had been made in the British Isles during the last eighteen months, and the results entirely confirmed those previously made on the Continent and in America, although the instruments used for recording the temperature were of a totally different pattern. These ascents had mostly been made at about the time of sunset, so that no possibility of solar influence might be present, but in every case (about sixty), when sufficient height had been reached, the temperature gradient had become negligible or of opposite sign. After calibrating many instruments he was convinced that the temperatures recorded were, with but few exceptions, trustworthy within two or three degrees centigrade.

The results, however, were most remarkable, and it was not surprising that doubts about their accuracy were expressed. It had been found that over places only a few hundred miles apart, and at the same time, the temperatures might be widely different, and within the same week and over the comparatively small area of the British Isles differences of 30° C. had been recorded, namely, $-40°$ C. at 15,000 metres, at Limerick on July 27, $-60°$ C., at Pyrton Hill, Oxon., on the same date, and $-69°$ C., at Pyrton Hill on July 29 and again on July 30. Very similar differences between Manchester, Ditcham Park, and Pyrton Hill had been noted on previous occasions.

The absence of any temperature gradient in the air is definite proof of the absence of any vertical circulation, but this alone did not present any difficulty. He (Mr. Dines) had always thought that the vertical circulation was chiefly due to the heat set free when aqueous vapour was condensed to water, and since it was known that the relative humidity was small at great heights, it might well be that above 10 or 12 kilometres there was no aqueous vapour, and therefore no vertical circulation. The difficulty was how large temperature differences could exist at small distances apart without producing convection currents. In a mass of gas at rest under a conservative system of forces the isobaric or isothermal surfaces must be coincident. In this case the temperature observations led to two contradictory results—they showed that there was no circulation and also that the isobaric and isothermal surfaces were not identical. At a height of 15 kilometres a very small change of pressure would produce a large adiabatic change of temperature, but it was difficult to see how, with so small a mass of air left above, changes of pressure could be produced. The accelerations produced by curvilinear motion of the air particles and by the effect of the earth's rotation an a moving body appeared to be far too small for the purpose. Was it possible that the upper air could carry a sufficiently strong electric current to be influenced by the earth's magnetic field, and so produce forces comparable with gravity? Prof. Schuster had suggested some such origin for the daily variation of the magnetic declination.

Mr. Gold said that any explanation of the existence of the isothermal layer must take into consideration the effect of atmospheric radiation. On the assumption that the radiation per unit area from a layer of gas was proportional to the mass of gas in the layer, and that the absorption followed the same law, he had worked out some results for the earth's atmosphere. If the atmosphere were of uniform constitution, so that the absorption by a layer of air of given mass was the same at whatever height the layer was taken, then the state of convective equilibrium could not exist to heights greater than those corresponding to a pressure equal to half the surface pressure. He found that for greater heights than this the radiation absorbed from the earth and the rest of the atmosphere alone was greater than that emitted at a temperature corresponding to the state of convective equilibrium. In consequence of this the temperature of the air in the upper layers would rise, and there would be a further increase owing to the absorbed solar radiation. In the actual case, the absorbing power of the atmosphere diminishes with increasing height owing to the diminution in the proportional amount of water vapour present. The absorbing power was therefore taken to be equal to $\alpha\,(q-p)$, where $\alpha$ and $q$ are constants. Two values were taken for $q$, for one of which the diminution in absorbing power was quicker, in the other slower, than the diminution in the proportion of water vapour present. The value of $\alpha$ was deduced from the observations of Langley, Paschen, and others.

The conclusions arrived at were:—

(1) If the temperature gradient in the lower layers of the atmosphere is such that $T \propto p^{\frac{2}{7}}$, *i.e.* is approximately adiabatic, and if the upper layer is isothermal, then the state $T \propto p^{\frac{2}{7}}$ must extend to a height greater than that for which $p = p_0/2$, and in general less than that for which $p = p_0/4$, where $p_0$ is the surface pressure.

(2) The temperature in the lower layers cannot be maintained by absorption of terrestrial and solar radiation; these layers tend to grow cooler, and their temperature is kept up by the supply of heat through convection from the earth's surface and by condensation of water vapour in the atmosphere.

(3) The lowest possible temperature in the atmosphere over a place at temperature 300° A. must be greater than 150° A. or 210° A., according as the atmosphere radiates and absorbs throughout the spectrum or transmits freely 25 per cent. of the earth's radiation.

Prof. Turner said that whereas meteorologists were perhaps primarily concerned with the facts themselves, and physicists with the causes of them, astronomers were interested in the effects of the existence of this isothermal layer, especially in the phenomena of atmospheric refraction. It had been usual to make certain assumptions about the upper air for the calculation of refraction, and these assumptions were now shown to be wrong. Were the refractions calculated on such assumptions wrong? The answer seemed to be that very rough assumptions were sufficient for astronomers; he had found, for instance, that the assumption of two homogeneous shells of air would give empirical results corresponding closely to the facts observed.

Further, no very great improvement was found by adding a third shell—the chief step came in taking two instead of one. Possibly this fact (that two shells were absolutely necessary, but a third was not so much needed) was in some way connected with the existence of two principal regions in the atmosphere.

Prof. J. J. Thomson asked if there was any indication of the thickness of the layer, and remarked that the ionisation in the atmosphere was a maximum at a layer considerably below this layer.

Dr. Walker stated that the Indian peasants were so ignorant that he had not yet ventured on sending up *ballons-sondes* there, the chances of recovering them being so remote.

## *THIRD INTERNATIONAL CONGRESS FOR THE HISTORY OF RELIGIONS.*

OXFORD has good reason to be proud of the success of the congress, which was held there from September 15 to September 18; not only was the general level of the papers high, but the attendance of members—nearly 600—was so large that the Transactions will contain, besides the presidential addresses, some of the more important papers in full, with an abstract of the remainder. The total number of papers was well over 100, hence the need for limitations.

At an Oxford congress of religions it was natural that a part should be played by the Father of Anthropology, and the enthusiasm with which Dr. Tylor was greeted when he introduced the president, Sir A. C. Lyall, was as flattering a tribute to his greatness as he could desire. The subject of Sir A. C. Lyall's address was religious conflicts and the conditions under which one religion attained predominance over its competitors; he held that State recognition has been indispensable to religious consolidation, and ascribed to the absence of State regulation the freedom characteristic of Hindu theology.

The congress was divided into nine sections, besides a general one for papers of wider import, and in each section a presidential address was delivered; Sir John Rhys dealt with Celtic religion, and pointed out that our evidence was precarious, and our knowledge inferential only; Prof. Giles said that the Chinese had a sky-god, Tien, who received, however, neither respect nor sacrifice; eventually this power became an abstraction; Mr. Hartland discussed, among other things, magic, a subject also dealt with by Dr. Jevons; Prof. Petrie discussed Egyptian religion, and pointed out that the prominence of the funerary cult in it was accidental and due to the rise of the bed of the Nile, which had covered up the Egypt of the living; in the life of the ordinary man, the local sacred animal or totem figured largely; the murder of a cat would have set Alexandria in flames, even down to Roman times.

Of the other papers, some were sensational, like that of Prof. Haupt, who maintained the non-Semitic descent of Christ; he argued that Galilee was denuded of Jews in 164 B.C., and that when the Jewish religion was reintroduced fifty years later, it was imposed on Assyrian colonists introduced by Tiglath Pileser; an effective criticism on this view was made by Dr. Gaster, who pointed out that the Jews would have been ready enough to seize on a much less valid ground for denying Christ's descent from David.

Dr. J. G. Frazer also dealt with Jewish beliefs, but his notes on them were the wonderful collections of parallel instances from all parts of the world which we expect from him; he traced the silent widow, for example, in North America, Madagascar, and Australia, where a two years' ban rests upon them, and has been perhaps a potent cause in the development of gesture language.

Dr. A. J. Evans read a paper on the cults of Minoan Crete, and pointed out that recent discoveries corroborated the views which he put forward in 1900; Minoan cults were predominantly aniconic, though images were also found; the cult objects were trees and pillars, and the double axe; the principal divinity was a nature goddess. As a pendant to this paper may be mentioned Miss Harrison's discussion of bird and pillar cults, in which she argued that the change from the "matriarchal" to the "patriarchal" stage caused a change of sex in the most important divinity.

Anthropologists are far from being agreed as to the definition of religion, and, not unnaturally, there was an attempt to define it in the section devoted to religions of the lower culture. Mr. Marrett held that Tylor's animism was far wider than religion, though it did not embrace all religion; the real criteria were two—first, the presence of *mana*, magico-religious force, and, secondly, the negative rites set up by a belief in *mana*, and commonly known as tabu; when the personal element became prominent in religion, animism came in; but it is really a primitive philosophy far wider than the supernatural.

Special interest attached to Dr. Seligmann's account of the Veddahs, from whom he has just returned; with them, as with many other races, fear was the main emotion, and at death they deserted the cave, leaving the body without food or fire; the cult of the dead was almost the central feature of the psychical life of the Veddahs. Funerary customs were also dealt with by Mr. T. C. Hodson in a paper on the Assam hill tribes, and by Mr. N. W. Thomas; the latter summarised Schmidt's views, as yet unpublished, as to the three strata in the population of Australia—old and new Australian and (?) Papuan—and pointed out that the burial customs largely followed the linguistic lines; in the south and west of Australia fear of the dead was found, and disposal of the body once for all; in the north and east the flesh was removed from the bones, and only with the burial of the latter was the spirit supposed to be dismissed to its own place; in the south the grave was the abode of the spirit.

Mr. W. W. Skeat's paper dealt with traces of totemism in the Malay Peninsula; totemism implies a group name, a belief in group kinship, and respect for "the blood," and of these the second is the primary one from which the others have sprung; but he was inclined to hold the view that totemism was originally independent of the notion of kinship; the Semang have not, as contended by Mr. Gomme, plant totemism, for plant names are far from general.

Among other papers may be mentioned one by Mr. Hollis on the Nandi, which suggests that their religion is a cross between Bantu ancestor cult and the Masai sky-god cult.

The social side of the congress was well looked after, and receptions were given by Prof. Gardner and Dr. Evans at the Ashmolean, Mr. Marrett and Dr. Farnell at Exeter, Profs. Driver and Sanday at Christ Church, Prof. Carpenter at Manchester College, and by the Mayor and Mayoress.

## *THE BRITISH ASSOCIATION.*

### SECTION I.

#### PHYSIOLOGY.

Opening Address by J. S. Haldane, M.D., F.R.S., Fellow of New College and Reader in Physiology in the University of Oxford, President of the Section.

*The Relation of Physiology to Physics and Chemistry.*

In choosing to address you on the relation of Physiology to Physics and Chemistry, I am aware that I have selected a subject which has already been treated from this chair by more than one distinguished predecessor. My excuse for returning to it again is that it not only possesses deep scientific interest for us all, but that a great deal remains to be said about it.

The majority of physiologists in recent times have expressed more or less clearly the opinion that Physiology is the application to living organisms of the methods and modes of explanation of Physics and Chemistry. It is, in short, Physics and Chemistry applied to the activities of living organisms; so that the only explanations aimed at in Physiology are, or ought to be, physical and chemical explanations. A minority, which is at present a growing one, I think, have either definitely dissented from this view, or have remained unconvinced of its truth. As one of this minority I should like to place before you as shortly as possible what seem to me to be the main reasons of our dissent. Let me add that I have carefully pondered over these reasons during many years of active physiological work.

When we look back on the history of Physiology is seems perfectly evident that physiological progress has been dependent on the progress of Physics and Chemistry. On this point there is no room for doubt. To take only one example, where should we be in the investigation of animal metabolism but for the ideas and experimental methods furnished to us by Physics and Chemistry? We should know next to nothing about respiration, animal heat, nutrition, or muscular and other work. Physiology depends at every turn on Physics and Chemistry, and its future progress will certainly be equally dependent on advances in physical and chemical knowledge. This consideration has, I imagine, weighed very heavily in the minds of those physiologists who have concluded that Physiology is nothing but applied Physics and Chemistry. A further fact which weighs equally heavily is that in spite of diligent search no fact contradicting the fundamental laws of conservation of matter and energy has been discovered in connection with living organisms.

When, however, we ask what progress has been made towards the physico-chemical explanation of physiological processes, we at once enter upon controversy. We may point to advances in some directions, but they are accompanied by the appearance of unforeseen difficulties in other directions. Again, to take animal metabolism as a typical instance, the investigations of the last hundred and twenty years have enabled us to assign ultimate physical and chemical sources to the energy and material leaving the body in various forms. We can assign to such sources the energy of animal heat, muscular work, glandular, nervous, and other activity: also the carbon dioxide, urea, salts, and many other substances which leave the body or are formed within it. All of this new knowledge may be regarded as progress towards a physico-chemical explanation of life.

But there is another aspect to be considered; for side by side with what I have just referred to there has been a different kind of increase of knowledge with regard to animal metabolism. This growth of knowledge relates to the manner in which the passage of energy and material through the body is regulated in accordance with what is required for the maintenance of the normal structure and activities of the body. In Liebig's time, for instance, it was believed that the rate of respiratory exchange was regulated simply by the supply to the body of oxygen and food-material. If one breathed faster, or if the barometric pressure or percentage of oxygen in the air increased, the respiratory exchange was assumed to be also increased, just as ordinary combustion outside the body would be increased by an increased supply of oxygen. If, again, one took in more food it was supposed that the excess went to increase the rate of combustion in the blood (*luxus consumption*), just as a fire is increased when more fuel is supplied. We now know that these assumptions were wholly mistaken, and that the respiratory movements, respiratory exchange, and corresponding consumption of food material in the body are regulated with astounding exactitude in accordance with bodily requirements. If, for instance, the body consumes more proteid, it economises a quantity of fat or carbohydrate equivalent in energy value to the proteid; and from day to day the amount of energy liberated in the body is very steady. With regard to the excretion of material by the kidneys a similar growth in knowledge can be traced. It is scarcely a century since the urine was regarded as equivalent more or less to the liquid part of the blood separated from the corpuscles, which were unable to pass through the very fine capillary tubules supposed to exist in the kidney substance. Gradually, however, we have learnt how extraordinarily delicate is the selective action which occurs in the kidney substance, and how efficiently this selective action maintains the normal composition of the blood. Scarcely a remnant is now left of the old filtration theories. Our ideas of tissue nutrition and growth have undergone a similar change; and it is hard to realise that only about seventy years ago Schwann could put forward the theory that cell formation and growth is a process of crystallisation.

One can multiply instances like these almost indefinitely; but I have, perhaps, said enough to show that if in some ways the advance of Physiology seems to have taken us nearer to a physico-chemical explanation of life, in other ways it seems to have taken us further away. On the one hand we have accumulating knowledge as to the physical and chemical sources and the ultimate destiny of the material and energy passing through the body; on the other hand an equally rapidly accumulating knowledge of an apparent teleological ordering of this material and energy; and for this teleological ordering we are at a loss for physico-chemical explanations. There was a time, about fifty years ago, when the rising generation of physiologists in their enthusiasm for the first kind of knowledge closed their eyes to the second. That time is past, and we must once more face the old problem of life.

Let us first look at the answer given to this problem by many of the older physiologists. Roughly speaking, they carried physical and chemical explanation of physiological processes as far as they could, and for the rest assumed that at some point or other the physical and chemical factors are interfered with and ordered in a teleological direction by something peculiar to living organisms—the "vital principle" or "vital force." This theory, if one can call it a theory, had the negative merit that it did not lead physiologists to ignore facts which they could not explain. But in practice the "vital force" became simply a convenient resting-place for these facts. It was assumed that the vital force could do anything and everything, and that it acts "from the blue" on physical and chemical processes. Yet its action was admittedly dependent on physical and chemical conditions, such as warmth, the presence of oxygen, &c. In fact, no consistent definition was given to the conception of "vital force." It consequently never could become a working hypothesis of any value. Chiefly on this account, I think, it practically disappeared from Physiology last century. Yet the class of fact which led to the theory of "vital force" is now more prominent than ever; and what du Bois Reymond called the "spectre" of Vitalism meets us at every turn, thinly disguised under such names as "cell autonomy," "vital processes," &c. It is useless to shut our eyes and deny the existence of this "spectre." We must fairly face and examine it.

However difficult it may be to imagine physico-chemical explanations of such processes as respiratory exchange, secretion, muscular activity, &c., there is nothing in the known facts relating to each process taken by itself to preclude the possibility of such explanations. Let us then follow the Euclidean method and assume provisionally that they are nothing but physico-chemical processes. This assumption evidently implies that each of the living cells concerned has a very complex and definite structure varying according to its functions. To take an example, a secreting cell in the kidney may be assumed to have a structure which responds to the stimulus of a certain percentage of urea or sodium chloride in the blood, and reacts in such a manner that energy derived from oxidation is so directed as to perform the work of taking up urea or sodium chloride from the blood and transferring it against varying osmotic pressures from one end of the cell to the other. This mechanism must also be assumed to have the property of maintaining itself in working order, and probably also of reproducing itself under appropriate stimuli, besides also performing various other functions. Its physico-chemical structure must thus be very definite and complex—to an extent which the older physico-chemical theories took no account of. If we look to the cells in other parts of the body we are met with the same necessity for assuming complexities of structure which seem to grow in extent with every advance in physiological knowledge, every discovery of new substances present within or around the cells, every discovery of new physiological reactions.

Let us not lose courage, however, but continue to follow the direction in which our assumption leads. In assuming that the body is an enormously complex physico-chemical structure we have only begun to face the difficulties of our hypothesis: for we have still to consider how this structure can have originated in accordance with the physico-chemical theory of life. The adult organism develops from a single cell, the fertilised ovum. It is certain that this cell does not contain in a preformed condition the structure of an adult organism. The conditions of environment in which any particular ovum develops itself are doubtless indefinitely complex from the physico-chemical standpoint, as indeed is the environment of any particular portion of matter existing anywhere. But these conditions also vary almost indefinitely in the case of different ova, whereas the adult organism to which the ovum gives rise reproduces in minute detail the enormously complex characters of the parent organism. We are thus driven to the assumption that the ovum contains within itself a structure which, given certain relatively simple conditions in the environment, reacts in such a way as to build up step by step, from materials in the environment, the structure of the adult organism. To effect this the germ-cell must have a structure almost infinitely more definite and complex than that of any cell in the adult organism. Difficult as it may be to form any conception of the mechanism of a secreting cell, it is infinitely more difficult to form the remotest idea of that of a germ-cell.

But we are still only at the beginning of the difficulty. The assumed tremendous mechanism of the germ-cell has been developed, together with the whole of the rest of the parent organism and countless other germ-cells, from a previous germ-cell. What must the "mechanism" of this cell have been? And that of its endless predecessors? We have reached the Euclidean *reductio ad absurdum*.

I might strengthen my argument by referring to the further difficulty over any physico-chemical conception of what occurs in the sexual fusion of the male and female cell, or in the process of partial reproduction after injury, or in the facts established by Driesch and others with regard to the extraordinary reproductive powers of each cell in developing embryos. But I have purposely confined my references to more simple and well-known facts; for the more simply the argument can be put, the better. I confess that as a physiologist I am struck with amazement at the manner in which heredity is often discussed by contemporary writers who endeavour to treat the subject from a mechanistic standpoint. Sometimes, indeed, the germ-cell is acknowledged to be a complicated structure, but at other times it is treated as a "plasma," which can be mixed with other "plasma," divided, or added to, as if for all the world it were so much treacle! I have tried to place clearly before you the assumptions in connection with heredity which to my mind make the physico-chemical theory of life unthinkable, even if it be tenaciously clung to in connection with those ordinary physiological phenomena where, as already explained, it has proved so disappointing.

Our aim as physiologists is to render physiological phenomena intelligible—in other words, to obtain general conceptions as to their nature. The point now reached is that the conceptions of Physics and Chemistry are insufficient to enable us to understand physiological phenomena. But if so, we need not sit down in despair, for we can look for other working conceptions. Are we justified in doing this? I think we are.

There is a prevalent popular idea that the world as presented to us under the conceptions of Physics and Chemistry is more than our own imperfect conception of reality, and corresponds completely with reality itself. Philosophy has shown us, however, that this idea must be erroneous; for if it were correct, knowledge of such a world would be impossible. This was first clearly pointed out almost two hundred years ago in this city by one of the greatest of Irishmen, George Berkeley, at that time a Fellow of Trinity College.[1] The lesson taught by Berkeley, Hume, and their successors is not that Physical Science is of less value than it appears to be, but that its fundamental hypotheses are only working hypotheses, applicable only so far as they successfully fulfil their purpose. Each different science is thus free to employ whatever working hypotheses may prove most useful in interpreting the order of phenomena with which it deals. We are thus perfectly justified in seeking to find a conception of life which will serve as a better working hypothesis than that of life as a physico-chemical process.

I venture to think that the conception we are in search of lies very near to hand and is indeed in common use, though in a form which has hitherto been too ill-defined for deliberate scientific employment. It is simply the conception of the living organism, which stands, or ought to stand, in the same relation to Biology as the conceptions of matter and energy to Physics, or of the atom to Chemistry. Let me try to give more definition to this conception. A living organism is distinguished by the fact that in it what we recognise as specific structure is inseparably associated with what we recognise as specific activity. Its activity expresses itself in the development and maintenance of its structure, which is nothing but the expression of this activity. Its identity as an organism is not physical identity, since from the physical standpoint the material and energy passing through it may be rapidly changing. In recognising it as an organism we are applying an elementary conception which goes deeper than the conceptions of matter and energy, since the apparent matter and energy contained in, or passing through, or reacting with, the organism are treated as only the sensuous expression of its existence. Even the environment is regarded as in organic relation with the organism, and not as a mere physico-chemical environment. It follows that for Biology we must clearly and boldly claim a higher place than the purely physical sciences can claim in the hierarchy of the sciences—higher because Biology is dealing with a deeper aspect of reality. It must also be the aim of Biology gradually to penetrate behind the sensuous veil of matter and energy which at present seems to permeate the organic world at all points.

1 "Treatise concerning the Principles of Human Knowledge," 1710.

Let us now see how the conception just defined can be used as a scientific working hypothesis. In accordance with it any form of physiological activity is presumably related essentially, and not accidentally, to the other details of activity and structure in the same organism. Stated generally, therefore, the problem of Physiology is not to obtain piecemeal physico-chemical explanations of physiological processes, but to discover by observation and experiment the relatedness to one another of all the details of structure and activity in each organism as expressions of its nature as an organism.

The first step in physiological or morphological discovery is to observe the bare sensuous fact of some detail of physical or chemical change, or of composition or structure, in connection with an organism. It is only, however, when we find that this detail is not accidental that it becomes of biological interest. We can observe its constancy or otherwise in the same organism or similar organisms—that is to say, the constancy of its relations to other details of structure and activity. Or we can by experiment search for the element of constancy when it is at first sight hidden from our view. In so far as we find this, it seems to me that we reach physiological or biological explanation; but evidently the process of reaching it is at any stage in knowledge only imperfectly realised, since new details of activity and structure are constantly being revealed.

Concrete examples will make the matter clearer, and I shall first take as an example the progress of knowledge in relation to animal heat. It was of course common knowledge from early times that in the higher animals a certain amount of warmth in the body is present during life. With the invention of the thermometer the body-temperature could be measured, and its extraordinary constancy observed. When Lavoisier measured the heat-production of an animal, and compared the output of heat with the output of carbon dioxide and disappearance of oxygen in respiration, an immense step forward was taken. This step was in two distinct respects a very great one. In the first place it revealed an element of identity between organic and inorganic phenomena, since heat-production in an animal was shown to be accompanied by chemical changes quantitatively identical with those accompanying heat-production by oxidation outside the body. In the second place, and from the distinctively physiological point of view, it revealed a fundamental relation between heat-production, respiratory exchange, and the consumption of food.

As regards the first of these points I should like to say definitely that I, for one, firmly believe that could we only understand them fully we could bring organic and inorganic phenomena under the same general conceptions. Lavoisier's discovery, like that of Mayer in relation to the sources of muscular energy, was a great advance in this direction. But this is a very different thing from an advance in the direction of rendering life intelligible in terms of physico-chemical conceptions as we commonly understand them. Lavoisier's discoveries did nothing in the direction of reducing to physico-chemical terms the apparent teleological or, as I should prefer to say, "physiological" element in the phenomena of animal heat.

It is to the second point that I wish to direct special attention at present. Lavoisier's discovery rapidly brought the phenomena of animal heat into direct relation, not only with respiration but with nutrition, circulation of blood, excretion, and other processes; and it was gradually discovered that the maintenance of a constant body-temperature renders physiologically intelligible a large number of phenomena in connection with different bodily activities—for instance, increased metabolism with fall of external temperature, sweating or increased circulation through the skin with muscular work, the relative constancy of metabolism during starvation, and the physiological equivalence of proteid, carbohydrate, and fat in proportion to their energy values. These phenomena are intelligible on the assumption that warm-blooded animals actively maintain a certain body-temperature, just as they maintain a certain bodily structure and composition. This mode of explanation is not a physico-chemical one, but I venture very confidently to assert that it is a physiological one, and in fact the only kind of explanation which really interests and appeals to a true physiologist. The thread of identity which has been traced through the phenomena just referred to seems to me to have proved a real scientific clue.

As another example I may perhaps be allowed to refer shortly to the regulation of breathing, as this is a subject on which I have recently been working. Current accounts of the clock-like action of the respiratory centre during normal breathing, with the expansion and contraction of the lungs acting as a sort of governor through the vagus nerves, always filled me with suspicion, as it seemed to me that such a regulation was altogether unlike a physiological one. This led me to investigate the matter further, along with Mr. Priestley; and we had the satisfaction of being able to prove that the ventilation of the lungs is actually regulated with exquisite exactness, in such a way as to keep the partial pressure of carbon dioxide in the alveolar air and presumably, therefore, in the arterial blood, constant. In reality, therefore, the lung ventilation is regulated in accordance with the requirements of respiratory exchange; and what seems to be true physiological explanation has been advanced a short stage.

The advance of knowledge with regard to the circulation might be made the text of a similar discourse. By a process of abstraction the circulation of the blood may be regarded as a mere mechanical process, connected only by the accidents of physical structure with other physiological processes. Under the influence of mechanistic theories the blood-pressure and rate of blood-flow through different organs were indeed for long supposed to be the primary determining cause of the physiological activities of these organs, just as the rate and depth of breathing were supposed to determine the consumption of oxygen by the body. Evidence is, however, accumulating on all hands that the blood-supply to various parts, like the air-supply to the lungs, is in reality determined by physiological requirements. In other words, it is a direct expression of the nature of the organism, just as the common-sense idea of life would lead us to expect.

I may pass next to a branch of physiological knowledge which is still in its early infancy. Under the influence of mechanistic ideas Physiology has for long left completely out of account investigation into the formation and maintenance of organic structure. For mechanistic explanations structure had to be assumed, and as a consequence anatomy was left high and dry in a position of helpless isolation. If, however, the real aims of Physiology are those which I have tried to indicate, the separation between Physiology and Anatomy must tend to disappear: for the structure no less than the activity of each part must be determined by its relations to the structure and activities of other parts in the organic whole of the living organism. We can investigate these relations, just as we investigate the connection of secretion with respiratory exchange, circulation, or the composition of the blood; and they must evidently be physiological relations. Our aim is not the hopeless one of giving a physico-chemical explanation of the development and maintenance of organic structure, but simply discover the physiological relations which determine the structure of each part and its maintenance. Many facts bearing on this subject have recently been brought to light by the application of experimental methods to embryology, and by the study of reproduction of lost or injured parts, and of grafting: also by the study of so-called "internal secretion" in connection with various organs. It seems clear, however, that we are only at the beginning of a vast development of knowledge in this direction, and that for this development far more refined methods of dealing with the chemistry of the body will be required.

It was in connection with the facts of reproduction and heredity that the difficulties of the mechanistic theory of life were found finally to culminate. For the distinctively biological theory of life, to which I have endeavoured to give some definition, these difficulties do not exist. They are, it is true, not solved; but they are set aside as being due to wrong initial assumptions and therefore purely artificial. The difficulty remains of reconciling the fundamental conceptions of Biology with those of Physics and Chemistry. This is, however, a matter of which the discussion must be handed over to Philosophy, which has many similar matters to deal with. If it is a fundamental axiom that an organism actively asserts or maintains a specific structure and specific activities, it is clear that nutrition itself is only a constant process of reproduction: for the material of the organism is constantly changing. Not only is there constant molecular change, but the living cells are constantly being cast off and reproduced. It is only a step from this to the reproduction of lost parts which occurs so readily among lower organisms; and a not much greater step to the development of a complete organism from a single one of the constituent cells of an embryo in its early stages. In all these facts we have simply manifestations of the fundamental characters of the living organism. The reproduction of the parent organism from a single one of its constituent cells separated from the body seems to me only another such manifestation. Heredity, or, as it is sometimes metaphorically expressed, organic memory, is for Biology an axiom and not a problem. The problem is why death occurs, what it really is, and why only certain parts of the body are capable of reproducing the whole. These questions carry us, at least in part, beyond the present boundary lines of Biology. They involve those ultimate questions which, as has just been pointed out, it is the province of Philosophy to deal with.

To turn to another set of questions, the distinctively biological standpoint in Biology involves a change in what has in recent times become the ordinary attitude towards organic evolution. Since our conception of an organism is different in kind, and not merely in degree, from our conception of a material aggregate, it is clear that in tracing back life to primitive forms we are getting no nearer to what is called abiogenesis. The result of investigation in this direction can only be to extend further the domain of Biology and widen biological ideas. Our aim must be, in short, not to reduce organic to inorganic phenomena, but to bring inorganic phenomena into the domain of Biology.

I am well aware that it will be strongly maintained that the change of front which I have urged as necessary involves the giving up of all real attempt at scientific explanation in Biology. As already explained, this is a philosophical question, and I shall not attempt to deal further with it here. What immediately concerns us as biologists is whether the change of front will further or hinder biological advance, particularly in Physiology. Now the first requisite of a working hypothesis is that it should work, and I have tried to point out that as a matter of fact the physico-chemical theory of life has not worked in the past and can never work. As soon as we pass beyond the most superficial details of physiological activity it becomes unsatisfactory; and it breaks down completely when applied to fundamental physiological problems, such as that of reproduction. Those who aim at physico-chemical explanations of life are simply running their heads at a stone wall, and can only expect sore heads as a consequence. It seems to me that the proposed change of front is only the conscious adoption of a common-sense idea which is somewhat vaguely, perhaps, present in the minds of all men, and which has in reality guided biological advance in the past. This idea, as I have tried to show, is a working hypothesis which actually works, and affords clear guidance for future advance.

I would fain add a few words as to the relation of Physiology to Psychology and Ethics: for this is a subject of deep human interest. We know that at any rate the higher organisms are conscious and intelligent. This fact brings Physiology into touch with a new element in the behaviour of organisms. The subject is far too great a one for me to attempt to discuss here, but I should like to say that it appears to me very clear that just as Biology is something more than Physics and Chemistry, so Psychology is something more than Physiology, with the added assumption that consciousness is tacked on to certain physiological processes, if such a crude conception has any definite meaning. We can, it is true, by a process of abstraction treat sensation from the purely physiological side, as in investigating the physiology of the sense-organs; but this is Physiology and nothing else; for we are leaving out of account the distinctive elements of consciousness. At our present stage of knowledge life is not intelligence, and men or animals as intelligent individuals involve a deeper aspect of reality than Biology deals with. Our fundamental physiological working hypothesis cannot be successfully applied to the phenomena of intelligence, and the sooner and more definitely this is realised the better for Physiology.

In conclusion, let me endeavour to state shortly the main contention which I have endeavoured to place before you. It is that in Physiology, and Biology generally, we are dealing with phenomena which, so far as our present knowledge goes, not only differ in complexity, but differ in kind from physical and chemical phenomena; and that the fundamental working hypothesis of Physiology must differ correspondingly from those of Physics and Chemistry.

That a meeting-point between Biology and Physical Science may at some time be found, there is no reason for doubting. But we may confidently predict that if that meeting-point is found, and one of the two sciences is swallowed up, that one will not be Biology.

## SECTON K.

### BOTANY.

OPENING ADDRESS BY F. F. BLACKMAN, M.A., D.Sc., F.R.S., PESIDENT OF THE SECTION.

*The Manifestations of the Principles of Chemical Mechanics in the Living Plant.*

### THE UNIFORMITY OF NATURE.

AMONG the phenomena of nature Man finds himself to be one of medium magnitude, for while his dimensions are about a billion times as great as those of the smallest atoms that compose him they are also about one-billionth part of his distance from the centre of his solar system.

From the vantage point of this medium magnitude the man of science scans eagerly the whole range of natural phenomena accessible to him with a strenuous desire for unity and simplification.

By the unwearying study of special sections of this long front of natural phenomena special guiding principles have been detected at work locally. No sooner has this been accomplished than, in obedience to this desire for continuity throughout, such principles have been freely extended on either side from the point of discovery.

Thus, the theory of probability, which dealt at first with so limited an occupation as drawing white and black balls out of an opaque bag, now is known as the only determinable factor in such remote things as the distribution of the duration of human lives and the effect of concentration of the colliding molecules in a solution upon the rate of their chemical change. Again, the principle of evolution discovered among living things has been extended, until to speak of the evolution of societies, of solar systems, or of chemical elements is now but commonplace.

The biologist, with all his special difficulties, has at least the limitation that he is only concerned with the middle range of the interminable hostile front of natural phenomena, and that for him is ordained the stubborn direct attack, leaving the brilliant attempts at outflanking movements to the astronomers on the one wing and the workers at corpuscular emanations on the other.

The atoms and molecules that the biologist has to deal with do not differ from those passing by the same names in the laboratories of chemistry and physics (at least no one suggests this), and their study may therefore be left to others. At the other end of the scale, with astronomical magnitudes we have not to deal, unless indeed we yield to the popular clamour to take over the canals on Mars as phenomena necessarily of biological causation.

In the study of that particular range of phenomena which is the special allotment of the physiologists, animal and vegetable, we have had ever before us the problem of whether there is not here some discontinuity in nature; whether the play of molecular and atomic forces occurring outside the living organism can ever account for the whole of the complexity and correlation of chemical and physical interactions demonstrable within the living structure.

As yet we are of course far from any answer to this question, and no one in a scientific assembly like this will call upon us for prophecies. Yet the subject to which I shall devote my Address has a bearing upon this question. I propose to consider a particular aspect of the relation of chemical changes in a test-tube to those taking place in a living growing plant, and this in the spirit of one who craves for continuity throughout natural phenomena.

The point of view from which the chemist regards the reaction taking place in his test-tube has undergone a change in the last twenty years, a change bringing it more into uniformity with that of the biologist. No longer content with an equation as a final and full expression of a given reaction, the chemist now studies with minutest detail and with quantitative accuracy the progressive stages of development of the reaction [1] and the effect upon it of varied external conditions, of light, temperature, dilution, and the presence of traces of foreign substances.

Perhaps it is too much to believe that this, as it were physiological, study of each reaction is the effect of some benign irradiation from the biological laboratory. At least, however, it is true that it is the modern study of "slow" chemical reactions which has made all this possible, and the living organism consists almost entirely of slow reactions. The earliest studied chemical reactions, those between substances which interact so quickly that no intermediate investigation can be made, did not of course lend themselves to this work, but nowadays whole classes of reactions are known which are only completed hours or days after the substances are initially mixed. To the slow reactions belong all the hydrolytic and dehydration changes of carbohydrates, fats, and proteids that bulk so largely in the metabolism of plants and animals, together with other fermentation changes such as are brought about by oxidases, zymases, and enzymes in general. This precise quantitative study of chemical reactions has been developing with remarkable acceleration for some twenty-five years, until it is grown almost into an independent branch of science, physical chemistry. This is sometimes called "general chemistry" because its subject is really the fundamental universal laws of the rate of chemical change, and these laws hold through all the families, genera, and species of chemical compounds, just as the same physiological laws apply to all the different types of plants.

Now if these laws are fundamental with all kinds of chemical change they must be at work in the living metabolic changes. If the chemical changes associated with *protoplasm* have any important factor or condition *quite different* from the state of things which holds when molecules react in aqueous solution in a test-tube, then it might happen that the operation of these principles of physical chemistry would be obscured and not very significant, though it is inconceivable that they should be really inoperative.

My present intention, then, is to examine the general phenomena of metabolism in an attempt to see whether the operations of these quantitative principles are traceable, and if so how far they are instrumental in giving a clearer insight into vital complexity.

### The Dominance of Irritability in Physiology.

I think that certain manifestations of these principles are indeed quite clear, though not generally recognised, and that this neglect is largely due to the dominance of what our German colleagues call "Reizphysiologie"—the notion that *every* change in which protoplasm takes part is a case of the "*reaction*" *of an* "*irritable*" *living substance to a* "*stimulus*." Now this general conception of protoplasmic irritability, of stimuli and reactions was, of course, a splendid advance, the early development and extension of which we owe largely to our veteran physiologist Prof. Pfeffer, of Leipzig. Great as is the service it has rendered to many departments of botany, yet in one direction, I think, it has overflowed its legitimate bounds and swamped the development of the physical-chemical concepts which I shall indicate later on. The great merit of the "stimulus and reaction" conception is that it supplies a very elastic general formula for the sort of causal connection that we find occurring in all departments of biology; a formula which allows the phenomena to be grouped, investigated, and formally expounded, whether they be the temporary turgor-movements of "sensitive" plants, the permanent growth movements of tropistic curvatures, or the complex changes of plant-form and development that result from present and past variations of external conditions.

The strength and the weakness of the conception lie in its extraordinary *lack of particularity*. When an irritable cell responds to a stimulus by a reaction nothing is implied about the mechanism connecting the *cause and the effect*, and nothing even about the relative magnitudes of these, but all this is left for special research on the case under consideration. The one natural chain of cause and effect that is recognised to be outside this comprehensive category is that rather uncommon one in which a definite amount of energy of one kind is turned into an equivalent definite amount of energy of another. Here we have a direct "equation of energy," whereas in a reaction to a stimulus we are said to have typically an "unloosing" effect—a liberation of potential energy by a small incidence of outside energy, as in the classical analogies, drawn from completely comprehended non-living things, of a cartridge exploded by a blow, or the liberation into action of a head of water by the turning of a tap.

So elastic a conception may be easily stretched to fit almost any sequence of phenomena with the apparent closeness that argues a bespoken garment. We must therefore be critically on our guard against cases of such sartorial illusion.

### The Principles of Chemical Mechanics.

That my consideration of particular cases may be intelligible it seems necessary that I devote a few minutes to outlining the four quantitative mechanical principles which govern every single chemical reaction, though much that I have to say has been drawn from elementary books on physical chemistry.

These four principles are concerned with (1) the nature of the reaction in question; (2) the amount of reacting substances that happen to be present; (3) the temperature at which the reaction is taking place; and (4) the influence of catalysts upon the reaction.

For the moment we will confine ourselves to the first two matters, and assume that catalysts are absent and the substances at constant temperature.

(1) The first principle that we have to consider is that which declares that no chemical reaction is really instantaneous, though the interaction of substances is often so fast that a direct measurement of its rate cannot be made; and, further, that every reaction has its own *specific reaction-velocity* which distinguishes it from other reactions. This is expressed by giving to each particular reaction a numerical *velocity-coefficient* which is low or high proportionally as the reaction is slow or quick.

(2) This coefficient only expresses the actual experimental velocity when the reacting substances are present in *unit* concentration, because difference of concentration is just the most important factor controlling the actual reaction-velocity.

If a solution of a substance A of unit concentration is undergoing change, then to keep this reaction going at its present rate fresh amounts of A must be added continually just to equal the amount removed by the reaction and so keep the substance up to unit concentration. The amount of A that had to be added thus per unit time would give an exact measure of the amount being decomposed, *i.e.*, of the specific velocity of this reaction.

If the reaction were started with A at double unit concentration, then twice as much A would have to be added *per* unit time to keep the reaction velocity constant at the double rate it would have started at.

And with higher concentrations proportionally more A would have to be added. It is therefore shown that the amount of chemical change going on in unit time is proportional to the concentration. This is a most fundamental principle of chemical mechanics, known as the *law of mass*, and it may be stated thus: *the amount of chemical change taking place at any time is always proportional to the amount of actively reacting substance (or substances) present.*

To carry out experiments by the procedure given above is in practice very difficult, and the velocities of reactions are never measured by the chemist in this way. In a living organism this continual bringing up of new supplies of

[1] Modern research has made it clear that reactions conventionally represented by complex equations of many interacting molecules really take place in a succession of simple stages, in each of which, perhaps, only two molecules interact.

material to maintain a constant rate of change is the ordinary way of life, but in the chemical laboratory procedure is different. There, definite amounts of substances are initially mixed in a vessel, and the reaction is allowed to progress by itself without further additions. In this case there is a continual falling off of the concentration of the substance, and so a corresponding diminution of the actual reaction-velocity.

In this procedure the diminution of the initial amount of substance can be actually measured by withdrawing small samples at intervals of time and analysing them. Let us consider a definite example. Cane-sugar can be hydrolysed, under various conditions, to give two molecules of hexose, according to the equation

$$C_{12}H_{22}O_{11}+H_2O=2C_6H_{12}O_6.$$

This reaction goes on, though extremely slowly, when an aqueous solution of cane-sugar is kept very hot in a beaker. Suppose we started with, say, 128 grams dissolved in a litre of water and traced the diminution of this amount down towards zero by withdrawing samples at intervals of time and analysing them. If we plotted the sugar-content of these successive samples against the times when they were taken we should get the curve given in Fig. 1. If we call $n$ minutes the time taken for the sugar to diminish from 128 grams to 64 grams, we should find that in the second $n$ minutes the sugar had fallen to 32 grams, after $3n$ minutes to 16 grams, and so on, the amount halving itself every $n$ minutes. Thus the amounts of cane-sugar hydrolysed in successive equal intervals are 64, 32, 16, 8, 4, 2, 1 grams, amounts in each case just exactly proportional to the quantity of cane-sugar then remaining in solution, thus exemplifying the law of mass.

Such a curve as A in Fig. 1, which changes by a constant multiple for successive units of time (here halving itself every $n$ minutes) is known as a logarithmic curve; the velocity of reaction at any moment is exactly indicated by the steepness of the curve at that moment; the velocity is greatest at first, and it declines to almost zero as the curve approaches the horizontal at the end of the reaction.

When instead of the decomposition of a single substance we deal with two dissolved substances, A and B, reacting together, then as *both* of them go on being thus used up, the amount of change must be ever proportional to the mass or amount of A present multiplied by the mass of B present.

There is a special important case when the amount of, say, B is in very great excess of that amount required to unite with the whole of A. Then all through the slow progress of the reaction the amount of B never becomes reduced enough to make appreciable difference to its mass, and it may be considered as practically constant all along. In such a case the rate of the reaction is found to be proportional simply to the amount of A present, and we get again the curve A, Fig. 1. Here the amount of A may be considered as a limiting factor to the amount of reaction; B being in such great excess never falls low enough to take a practical part in determining the velocity.

The case of the hydrolysis of cane-sugar in aqueous solution is just such a case. The water itself enters into the reaction, but so little is used up in relation to the enormous excess present that the amount remains practically constant, and the rate of hydrolysis of the cane-sugar is determined only by the amount of the cane-sugar present at any moment.[1]

(3) We have now shown how the actual amount of chemical change going on in a solution is determined by the combined effect of (1) the specific reaction velocity, and (2) the law of mass. We have next to point out that the specific reaction coefficient is not the same in all circumstances, but is affected by variations of external conditions, always by temperature, and generally by the presence of traces of so-called catalysts.

The relation to temperature we will postpone, and proceed to consider our third principle, the acceleration of reaction velocity by *catalytic agents*.

It has long been known that small additions of various foreign substances may have a great effect in increasing the rate at which a reaction is proceeding. Thus this hydrolysis of cane-sugar, so slow with pure water, goes at a fair velocity if a few drops of a mineral acid are added to the solution, while the addition of a trace of a particular enzyme (invertase from plant or animal) enormously increases the rate of change, so that the whole 128 grams of cane-sugar are soon hydrolysed to hexose. The reaction progresses quantitatively in the same sort of way as before, giving a logarithmic curve of sugar-content. Indeed the same graphic curve, Fig. 1, A, would represent the facts if the value of $n$ were reduced from many hundred minutes to quite a few.

The most striking point about this new state of things is that the added body is not used up by its action, but the acid or enzyme is still present in undiminished amount when the reaction is completed.

Such actions were at first styled "contact" actions, but are now known as catalytic actions, because we have learned that the catalyst does not work just by contact

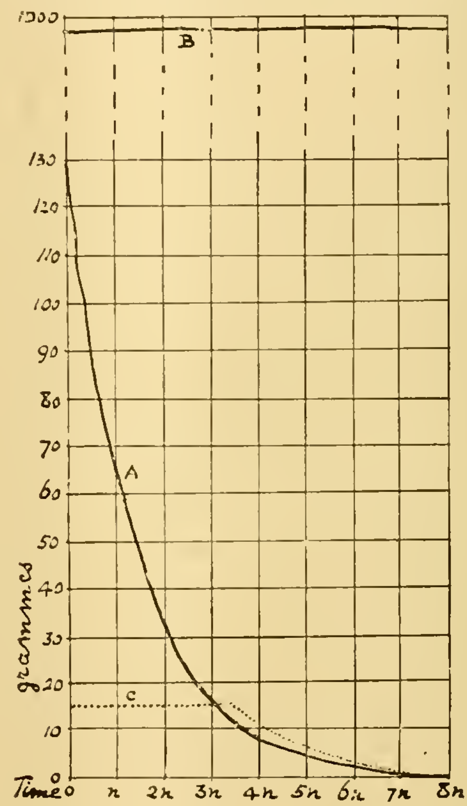


FIG. 1.

but by combining with the sugar to form an intermediate addition compound, and that this compound is then split up by the water liberating the catalyst again, but freeing the sugar part, not as cane-sugar, but combined with the water to form two molecules of hexose.

On many chemical reactions, finely divided metals such as platinum and gold have a very powerful catalytic action. Thus platinum will cause gaseous hydrogen and oxygen to unite at ordinary temperatures, and will split up hydrogen dioxide with the formation of oxygen. The intermediate stages in this catalytic decomposition may be summarily simplified to this—

$$H_2O_2+Pt=PtO+H_2O \text{ and } PtO+H_2O_2=Pt+O_2+H_2O.$$

Thus the reaction goes on and on by the aid of the appearing and disappearing "intermediate compound" PtO until at the end the $H_2O_2$ is all decomposed and the platinum is still present unaffected.

The enzymes are the most powerful catalytic agents known, and most of them are specifically constituted to

[1] 128 grams cane sugar unite with 6·7 grams water in hydrolysis, and in our experiment nearly 1000 grams of water are present.

effect the hydrolysis, oxidation, reduction, or splitting of some definite organic compound or group of compounds containing similar radicals.

Innumerable enzymes have in late years been isolated from the plant-body, so that it would seem that there is one present catalytically to accelerate each of the slow single changes that in the aggregate make up the complex metabolism of the plant.

The law of mass applies with equal cogency to *catalytic* reactions. If twice the amount of acid is added to a solution of cane-sugar (or twice the amount of enzyme) then the reaction-velocity is doubled, and hydrolysis proceeds twice as fast. As the catalyst is not destroyed by its action, but is continually being set free again, the concentration of the catalyst remains the same throughout the reaction; while, on the contrary, the amount of cane-sugar continually decreases.

If the catalyst be present in great excess the amount of hydrolysis will be limited by the amount of cane-sugar present, and as this is used up so the reaction will progress by a logarithmic curve as in Fig. 1, A. In this case B may represent the amount of catalyst. If, on the contrary, there is a large amount of sugar and very little acid or enzyme present, so that the catalyst becomes the limiting factor, then we happen upon a novel state of things; for by the law of mass the rate of hydrolysis will now remain constant for some time until the excess of sugar is so far reduced that it in turn becomes a limiting factor to the rate of change. In this case the velocity curve would consist of a first phase with a straight horizontal line of uniform reaction-velocity leading into the second phase of a typical falling logarithmic curve (see Fig. 1, C). These conditions have been experimentally examined by Horace Brown and Glendinning, and fully explained and expounded by E. F. Armstrong in part ii. of the critical "Studies in Enzyme Action."[1]

Having now outlined the three fundamental principles of reaction-velocity, the law of mass, and the catalytic acceleration of reaction-velocity, we are in a position to consider the broad phenomena of metabolism or chemical change in the living organism from the point of view of these principles of chemical mechanics.

### The Metabolism of the Plant considered as a Catalytic Reaction.

Plants of all grades of morphological complexity, from bacteria to dicotyledons, have this in common, that throughout their active life they are continually growing. Putting aside the *qualitative* distribution of growth that determines the morphological form, as a stratum of phenomena above the fundamental one that we are about to discuss, we find that this growth consists in the assimilation of dead food-constituents by the protoplasm with a resulting increase in the living protoplasm accompanied with the continual new formation of dead constituents, gaseous $CO_2$, liquid water, solid cellulose, and what not. This continual flux of anabolism and katabolism is the essential character of metabolism, but withal the protoplasm increases in amount by the excess of anabolism over katabolism.

Protoplasm has essentially the same chemical composition everywhere, and in the whole range of green plants the same food-materials seem to be required; the six elements of which proteids are built are obviously essential in quantity as building material, but in addition small amounts of Fe, Ca, K, Mg, Na, Cl, and Si are in some other way equally essential. What part these secondary elements play is still largely a matter of hypothesis.

Regarding metabolism thus crudely as if it were merely a congeries of slow chemical reactions, let us see how far it conforms to the laws of chemical mechanics we have outlined.

If the supply of any one of these essential elements comes to an end, growth simply ceases and the plant remains stationary, half-developed. If a Tropæolum in a pot be watered with dilute salt-solution, its stomata soon close permanently, and no $CO_2$ can diffuse in to supply the carbon for further growth of the plant. In such a condition the plant may remain for weeks looking quite healthy, but its growth may be quite in abeyance.

[1] Proc. Roy. Soc., vol. lxxiii., 1904, p. 511.

In agricultural experience, in manuring the soil with nitrogen and the essential secondary elements, the same phenomenon is observed when there is a shortage of any single element. If a continuous though inadequate supply of some one element is available, then the crop development is limited to the amount of growth corresponding to this supply. Agriculturists have formulated the "law of the minimum," which states that the crop developed is limited by the element which is minimal, *i.e.*, most in deficit. Development arrested by "nitrogen-hunger" is perhaps the commonest form of this. All this is of course in accordance with expectation on physical-chemical principles. The quantity of anabolic reaction taking place should be proportional to the amount of actively reacting substances present, and if any one essential substance is quite absent the whole reaction must cease. It therefore seems clouding a simple issue and misleading to say of a plant which, from the arrested development of nitrogen-hunger, starts growth again when newly supplied with nitrogen that this new growth is a response to a "*nitrogen stimulus*." It would appear rather to be only the removal of a limiting condition.

Let us now move on a stage. Suppose a growing plant be liberally supplied with all the thirteen elements that it requires, what, then, will limit its rate of growth? Fairy bean-stalks that grow to the heavens in a night elude the modern investigator, though some hope soon to bring back that golden age with overhead electric wires and underground bacterial inoculations. If everything is supplied, the metabolism should now go on at its highest level, and quantities of carbon, nitrogen, hydrogen, and oxygen supplied as $CO_2$, nitrates, and water will interact so that these elements become converted into proteid, cellulose, &c. Now this complex reaction of metabolism only takes place in the presence of protoplasm, and a small amount of protoplasm is capable of carrying out a considerable amount of metabolic change, remaining itself undestroyed. We are thus led to formulate the idea that metabolism is essentially a catalytic process. In support of this we know that many of the inherent parts of the protoplasmic complex are catalytic enzymes, for these can be separated out of the protoplasm, often simply by high mechanical pressure. We know, too, nowadays that the same enzymes that accelerate katabolic processes also accelerate the reverse anabolic processes.

In time a small mass of protoplasm will, while remaining itself unchanged, convert many times its own weight of carbon from, let us say, the formaldehyde (HCHO) of photosynthesis to the carbon dioxide ($CO_2$) of respiration.

If metabolism is a complex of up-grade and down-grade changes catalysed by protoplasm we must expect the amount of metabolism to obey the law of mass and to be proportional to the masses of substances entering into the reaction. The case when any one essential element is a limiting factor we have already considered. When all are in excess, then the *amount of the catalyst present* becomes in its turn the limiting factor. Transferring this point of view to the growing plant, we expect to find the limited mass of protoplasm and its constituent catalysts setting a limit to the rate of metabolic change in the extreme case where all the materials entering into the reaction are in excess. When once this supply is available further increase in supplies cannot be expected to accelerate the rate of growth and metabolism beyond the limit set by the mass of protoplasm. This, of course, is in accordance with common experience. The clearest experimental evidence is in connection with respiration and the supply of carbohydrates—this, no doubt, because the carbohydrate material oxidised in respiration is normally stored inside plant-cells in quantity and can be estimated. When the supplies for an internal process have to be obtained from outside, then we have the complications of absorption and translocation to obscure the issue, especially in the case of a higher plant.

Let us first take a case where the carbohydrate supply is in excess and the amount of catalytic protoplasm is small and increasing. Thus it is in seeds germinating in the dark: respiration increases day by day for a time, though carbohydrate reserves are steadily decreasing. Palladine[1] has investigated germinating wheat by analysing

[1] "Revue gén. de Botanique," tome viii., 1896.

the seedlings and determining the increase of the essential (non-digestible) proteids day by day. The amount of these proteids he regards as a measure of the amount of actual protoplasm present. Assuming this to be so, he finds an approximately constant ratio between the amount of protoplasm at any stage and the respiration.

As germination progresses in the dark the supplies of reserve carbohydrate presently fail, and then the respiration no longer increases in spite of the abundant protoplasm. According to our thesis the catalyst is now in excess and the $CO_2$ production is limited by the shortage of respirable material.

This second type of case was more completely investigated by Miss Matthæi and myself in working on the respiration of cut leaves of cherry-laurel kept starved in the dark. For a time the $CO_2$ production of these non-growing structures remains uniform, and then it begins to fall off in a logarithmic curve, so that the course of respiration is just like c in Fig. 1. We interpret both phenomena in the same way: in the initial level phase the respirable material in the leaf is in excess, and the amount of catalytic protoplasm limits the respiration to the normal biological level; in the second falling phase some supply of material is being exhausted, and we get a logarithmic curve controlled by the law of mass, as much, it would seem, as when cane-sugar is hydrolysed in aqueous solution.

After these two illustrations of the action of the law of mass from the more simple case of respiration we return to the consideration of the totality of metabolic reactions as exemplified in growth.

What should we expect to be the ideal course of growth, that is, the increase of the mass of the plant regarded as a complex of reactions catalysed by protoplasm? Let us consider, first, the simplest possible case, that of a bacterium growing normally in a rich culture solution. When its mass has increased by anabolism of the food material of the culture medium to a certain amount it divides into two. As all the individuals are alike, counting them would take the place of weighing their mass. The simplest expectation would be that, under uniform conditions, growth and division would succeed each other with monotonous regularity, and so the number or mass of bacteria present would double itself every *n* minutes. This may be accepted as the ideal condition.

The following actual experiment may be quoted to show that for a time the ideal rate of growth is maintained, and that at the end of every *n* minutes there is a doubled amount of protoplasm capable of catalysing a doubled amount of chemical change and carrying on a doubled growth and development.

From a culture of *Bacillus typhosus* in broth at 37° C. five small samples were withdrawn at intervals of an hour, and the number of bacteria per unit volume determined by the usual procedure. The number of organisms per drop increased in the following series: 6·7, 14·4, 33·1, 70·1, 161·0.[1] This shows a doubling of the mass of bacteria in every fifty-four minutes and is the case actually represented in the strictly logarithmic curve of Fig. 2.

We may quote some observations made by E. Buchner[2] of the rate at which bacteria increase in culture media. *Bacillus coli communis* was grown at 37° C. for two to five hours, and by comparison of the initial and final numbers of bacteria the time required for doubling the mass was calculated. Out of twenty-seven similar experiments a few were erratic, but in twenty cases the time for doubling was between 19·4 and 24·8 minutes, giving a mean of 22 minutes. This produces an increase from 170 to 288,000 in four hours. No possible culture medium will provide for prolonged multiplication of bacteria at these rates.

Cohn[3] states that if division takes place every sixteen minutes, then in twenty-four hours a single bacterium 1$\mu$ long will be represented by a multitude so large that it requires twenty-eight figures to express it, and placed end to end they would stretch so far that a ray of light to travel from one end to the other would take 100,000 years.

The potentialities of protoplasmic catalysis are thus made clear, but the actualities are speedily cut short by limiting factors.

For a while, however, this ideal rate of growth is maintained. At the end of every *n* minutes there is a doubled amount of protoplasm present, and this will be capable of catalysing twice the amount of chemical change and carrying on a doubled amount of growth and development. This is what common sense and the law of mass alike indicate, and is exactly what this logarithmic curve in Fig. 2 expresses.

This increase of the amount of catalytic protoplasm by its own catalytic activity is an interesting phenomenon. In Section K we call it growth, attribute it to a specific power of protoplasm for assimilation (in the strict sense), and leave it alone as a fundamental phenomenon, but are much concerned as to the distribution of the new growth in innumerable specifically distinct forms. In the Chemical Section they call this class of phenomenon "autocatalysis," and a number of cases of it are known. In these a chemical reaction gives rise to some substance which happens to catalyse the particular reaction itself, so that it goes on and on with ever-increasing velocity. Thus, we said that free acid was a catalyst to the hydrolysis of cane-sugar; suppose now that free acid were one of the products of the hydrolysis of sugar, then the catalyst would continually increase in amount in the test-tube, and the reaction would go faster and faster. Under certain conditions this actually happens. Again, when methyl acetate is hydrolysed we normally get methyl alcohol and free acetic acid. This free acid acts as a catalyst to the hydrolysis, and the rate of change continually accelerates. Here, if the supply of methyl acetate were kept up by constant additions, the reaction would go faster and faster with a logarithmic acceleration, giving a curve of velocity identical with Fig. 2, A.

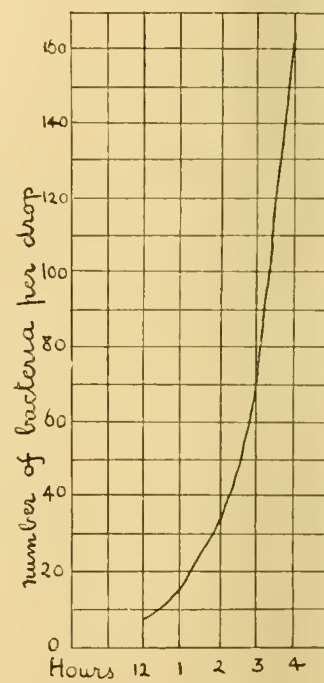


FIG. 2.

For a clear manifestation of this autocatalytic increase in the plant it is, of course, essential that the supply of food materials to the protoplasm be adequate.

Another case where we might look for a simple form of this autocatalytic increase in the rate of conversion of food materials to anabolites would be in the growth of a filamentous alga, like Spirogyra. Here, as in the bacterium, all the cells are still capable of growth. In this case the food-material needed in greatest bulk is carbon, which has to be obtained by photosynthesis. Some experiments have been started in the Cambridge Laboratory on the rate of growth of Spirogyra in large tubs of water kept at different temperatures and with varying facilities for photosynthesis and metabolism. Under rather depressing conditions the Spirogyra took several days to double its weight—a rate of metabolism out of all comparison slower than that of bacteria. Experiments on these lines, with the different food materials as limiting factors, should give instructive results.

We turn now to consider the growth of a flowering plant. Here conditions are more complex, and we know that at the flowering stage or end of the season the growth

[1] For this unpublished experiment on bacterial growth I am indebted to Miss Lane-Claypon, of the Lister Institute of Preventive Medicine.

[2] Buchner, "Zuwachsgrossen u. Wachsthumsgeschwindigkeiten" (Leipzig, 1901).

[3] Cohn, "Die Pflanze," p. 438 (Breslau, 1882).

diminishes considerably. This difference from a simple alga or bacterium we can only regard as a secondary acquisition in relation to the external conditions—either a reaction to a present external stimulus or to the memory of past stimuli. In a flowering plant, too, all the cells do not continue to grow; many cells differentiate and cease to grow, and also some of the groups of meristem remain dormant in axillary buds. Clearly the growth curve cannot continue to accelerate logarithmically, and in later phases it must tail off; the "grand period" which growth is said to exhibit is another way of stating this. It will, however, be of great interest to us to see what will be the form of the curve of growth during the early period of development.

The importance of this class of work has been realised in Geneva, and detailed work is now being done under the inspiration of Prof. Chodat[1] in which the curve not only of growth (fresh weight) but of the uptake of all the separate important elements in selected plants is being carefully followed.

With plants grown in the open, climatic disturbances must occur. We shall therefore figure a curve for the fresh weight of a maize plant grown in water-culture. This is prior to the Geneva work, and due to Mlle. Stefanowska,[2] who has studied also the growth-curves of small animals. The first phase of the curve, lasting some fifty days, shows strictly uniform acceleration, doubling the weight of the plant every ten days (Fig. 3). The precise external conditions are not stated.

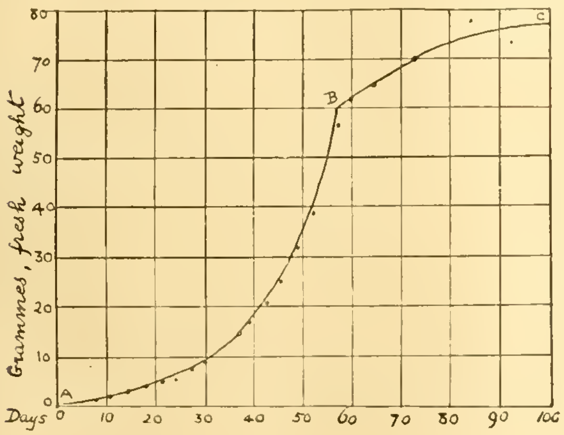


Fig. 3.

In spite of the morphological complexity the autocatalytic reaction of growth is apparently not checked by inadequate supplies before the plant enters rather suddenly upon the second phase. Here, from the present point of view, we consider that the progress of growth is interrupted, not by the primary physical-chemical causes, but by secondary causes, presumably to be classed in the category of stimulus and reaction.

The numerous curves for the accumulation of different organic and mineral constituents worked out for barley and buckwheat at Geneva are of similar form, but do not keep up the uniform rate of doubling so well as does the curve of total fresh weight.

In this connection the tall and dwarf forms of the same plant present an interesting problem, and some experiments have been started on sweet peas at Cambridge. At the time of germination the seedlings weigh about the same, whereas at the end of the season the weight of a tall plant is many times that of a dwarf "cupid" growing alongside under similar conditions. Is the difference due to a less vigorous autocatalysis in the dwarf form, so that throughout its growth it takes a greater number of days to double its weight? Construction of the curves of growth through the season will show whether it is this or some other alteration in the form of the curve.

I now propose to say a few words about one last point in connection with growth considered as a phenomenon of catalysis before passing on to deal with the effects of temperature.

Of the metallic elements that are essential for the growth of plants some occur in such minute quantities that one can only imagine their function is catalytic. If iron, for instance, played any part in metabolism which involved its being used up in any building material or by-product of metabolism, then a larger amount than actually suffices should be advantageous. If its function is catalytic the iron would go on acting indefinitely without being consumed, and so a minute trace might serve to carry out some essential, and even considerable, subsection of metabolism.

Elements like manganese, magnesium, and iron are often associated with non-vital catalytic action, and a preparation of iron has recently been quantitatively investigated which seems to have literally all the properties of an organic oxydase from plant tissues.[1]

So long ago as 1869 Raulin observed that traces of unessential salts, in particular those of zinc, added to the culture medium in which he grew the fungus Sterigmatocystis caused a rapid acceleration of the growth rate. The time that the mycelium took to double its weight was now reduced to a half or even a third. This continued enormous effect of so small a trace of substance is possibly to be regarded as an added catalyst to the normal protoplasmic apparatus. This sort of effect is currently labelled "chemical stimulation," and has been interpreted as an attempt of the fungus to grow away from an unpleasant environment. To me it looks as if such chemical stimulation were really another example of the injudicious extension of the concept of stimulus and reaction.

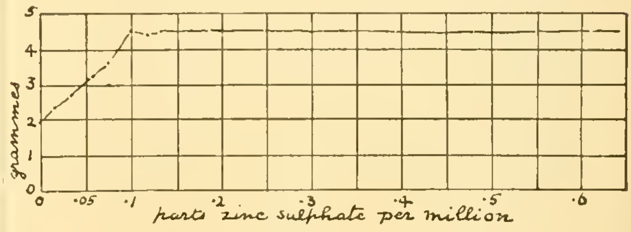


Fig. 4.

This effect of zinc upon the growth of mycelium has recently been verified and extended by Javillier,[2] who has made comparative cultures with increasing doses of zinc salt. He grew Sterigmatocystis for four days at 34° C. in media with graded additions of zinc salts. As the graphic representation shows, he finds a continuous regular increase of the number of grams of final dry weight with doses up to 0·00001 per cent., and then no greater but an equal effect up to 100 times as large a dose.

This form of curve with uniform rise at first, abruptly changing to a level top, suggests, as I have pointed out elsewhere,[3] the cutting-off of the primary rising effect by a limiting factor. In this case presumably the limit set by some other subsection of the metabolism has been attained.

### Acceleration of Reaction-velocity by Temperature.

We now turn to consider the fourth and last of the principles of chemical mechanics which we might expect to find manifested in metabolism.

It is a universal rule that rise of temperature quickens the rate at which a chemical reaction proceeds. Of course, in some rare conditions this may not be obvious, but be obscured by superposed secondary causes; but almost always this effect is very clearly marked.

Further, the nature of the acceleration is a peculiar one.

[1] A. Monnier, "Les Matières minérales et la Loi d'Accroissement des Végétaux," Geneva, 1905; N. Déléano, "Le Rôle et la Fonction des Sels minéraux dans la Vie de la Plante," Geneva, 1907. See also the independent work of Tribot, *Comptes rendus de l'Acad. des Sciences*, October 14, 1907.

[2] Stefanowska, *Comptes rendus de l'Acad. des Sciences*, February 1, 1904.

[1] J. Wolff, "Des Péroxydiastases artificielles," *Comptes rendus de l'Acad. des Sciences*, June 9, 1908.

[2] *Comptes rendus de l'Acad. des Sciences*, December, 1907.

[3] "Optima and Limiting Factors," *Annals of Botany*, vol. xix., April, 1905.

Rise of temperature affects nearly all physical and chemical properties, but none of these is so greatly affected by temperature as is the velocity of chemical reaction. For a rise of 10° C. the rate of a reaction is generally increased two or three fold, and this has been generalised into a rule by van't Hoff. As this increase is repeated for each successive rise of 10° C. either by the same factor or a somewhat smaller one, the acceleration of reaction-velocity by temperature is logarithmic in nature, and the curve representing it rises ever more and more steeply. Thus keeping within the vital range of temperature a reaction with a temperature factor of ×2 per 10° C. will go sixteen times as fast at 40° C. as at 0° C., while one with a factor of ×3 will go eighty-one times as fast.

This general law of the acceleration of reactions by temperature holds equally for reactions which are being accelerated by the presence of catalysts. As we regard the catalyst as merely providing for the particular reaction it catalyses, a quick way round to the final stage by passing through the intermediate stage of forming a temporary addition-compound with the catalyst itself, so we should expect rise of temperature to accelerate similarly these substituted chemical reactions.

If this acceleration is a fundamental principle of chemical mechanics it is quite impossible to see how vital chemistry can fail to exhibit it also.

### Acceleration of Vital Processes by Temperature.

At present we have but a small number of available data among plants to consider critically from this point of view. But all the serious data with which I am acquainted, which deal with vital processes that are to be considered as part of the protoplasmic catalytic congeries, do exhibit this acceleration of reaction-velocity by temperature as a primary effect.[1]

Let us briefly consider these data. On the katabolic side of metabolism we have the respiratory production of $CO_2$, and opposed to it on the anabolic side the intake of carbon in assimilation.

As a measure of the rate of the metabolic processes constituting growth we have data upon the division of flagellates; and finally there is the obscure process of circulation of protoplasm.

The intensity of $CO_2$ production is often held to be a measure of the general intensity of metabolism, but any relation between growth-rate and respiration has yet to be clearly established. Our science is not yet in the stage when quantitative work in relation to conditions is at all abundant; we are but just emerging from the stage that chemistry was in before the dawn of physical chemistry.

Taken by itself the $CO_2$-production of an ordinary green plant shows a very close relation with temperature. In the case of the cherry-laurel worked out by Miss Matthaei and myself the respiration of cut leaves rises by a factor of 2·1 for every 10° C. (See Fig. 5, Resp.) This has been investigated over the range of temperatures from 16° C. to 45° C. At this higher temperature the leaves can only survive ten hours in the dark, and their respiration is affected in quite a short time, but in the initial phases the $CO_2$ output has the value of 0·0210 gr. per hour and unit weight of leaf, while at 16°·2 C. the amount is only 0·0025 gr. $CO_2$. Thus the respiration increases over a range of ten-fold with perfect regularity solely by increase of temperature. No reaction in a test-tube could show less autonomy. At temperatures above 45° C. the temperature still sooner proves fatal unless the leaf is illuminated so as to carry out a certain amount of photosynthesis and compensate for the loss of carbon in respiration. Thus, with rising temperature, there is at no time any sign of an optimum or of a decrease of the intensity of the *initial* stage of respiration.

Here, then, on the katabolic side of metabolism we have no grounds for assuming that "temperature-stimuli" are at work regulating the intensity of protoplasmic respiration, but we find what I can only regard as a purely physical-chemical effect. The numbers obtained by Clausen[2] for the respiration of seedlings and buds at different temperatures indicate a temperature coefficient of about 2·5 for a rise of 10° C.

To this final process of katabolism there could be no greater contrast than the first step of anabolism, the assimilation of carbon by the protoplasm as a result of photosynthesis. We must therefore next inquire what is the relation of this process to temperature.

This question is not so simple, as leaves cannot satisfactorily maintain the high rate of assimilation that high temperatures allow. The facts of the case were clearly worked out by Miss Matthaei,[1] the rate of assimilation by cherry-laurel leaves being measured from −6° C. to +42° C. Up to 37° C. the curve rose at first gently and then more and more steeply, but on calculating out the values it is found that the acceleration for successive rises of 10° C. becomes less and less. Between 9° C. and 19° C. the increase is 2·1 times, the highest coefficient measured, and exactly the same coefficient as for respiration in this plant, which in itself is a striking point, seeing how different the processes are. (See Fig. 5, Assim.) The decrease of the coefficient with successive rises is a state of things which is quite general among non-vital reactions. A critical consideration of the matter leads one to the conclusion, however, that this failure to keep up the temperature acceleration is really due to secondary

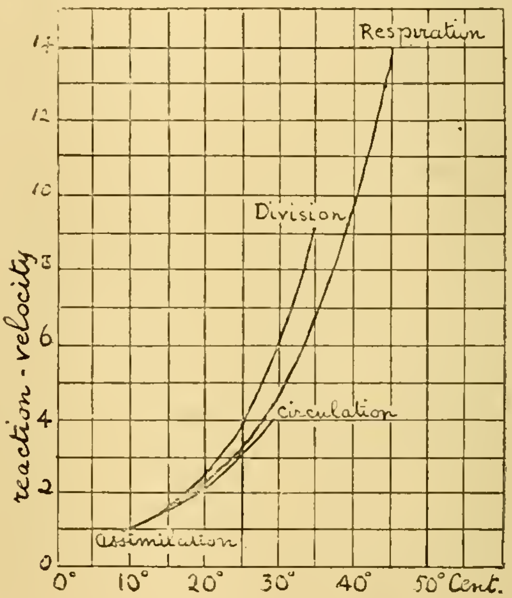


Fig. 5

causes, as is also the appearance of an optimum at about 38° C. Some of these causes have been discussed by me elsewhere,[2] and I hope to bring a new aspect of the matter before the Section in a separate communication. The conclusion formerly come to was that probably in its initial stages assimilation at these very high temperatures started at the full value indicated by a theoretically constant coefficient, but that the protoplasm was unable to keep up the velocity, and the rate declined. It must be borne in mind here that quite probably no chloroplast since the first appearance of green cells upon the earth had ever been called upon for anything like such a gastronomic effort as these cherry-laurel leaves in question. It is not to be wondered that their capacities speedily declined at such a banquet, and that the velocity-reaction of anabolic synthesis traces a falling curve in spite of the keeping up of all the factors concerned, to wit, temperature, illumination, and supply of $CO_2$. This decline is not permanent, but after a period of darkening the power of assimilation returns. Physical-chemical parallels can easily be found among cases where the accumulation of the products of a

[1] A collection of twenty cases, mostly from animal physiology, by Kanitz (*Zeits. für Elektrochemie*, 1907, p. 707), exhibits coefficients ranging from 1·7 to 3·3.

[2] *Landwirtschaftliche Jahrbücher*, Bd. xix., 1890.

[1] Phil. Trans. Roy. Soc., Ser. B, vol. cxcvii., 1904.

[2] "Optima and Limiting Factors," *Annals of Botany*, vol. xix., April, 1905.

reaction delays the apparent velocity of the reaction, but this complicated case may be left for further research.

In relation to assimilation, then, we must say that owing to secondary causes the case is not so clear over the whole range of temperature as that of respiration, but that at medium temperatures we have exactly the same relation between reaction-velocity and temperature.

We may consider now some data upon the combined net result of anabolic and katabolic processes. Such total effects are seen in their clearest form among unicellular saprophytic organisms for which we have a few data. Mlle. Maltaux and Prof. Massart[1] have published a very interesting study of the rate of division of the colourless flagellate *Chilomonas paramoecium* and of the agents which they say stimulate its cell-division, in particular alcohol and heat.

They observed under the microscope the time that the actual process of division into two took at different temperatures. From twenty-nine minutes at 15° C. the time diminished to twelve minutes at 25° C., and further to five minutes at 35° C. The velocities of the procedure at the three temperatures 10° C. apart will therefore be in the ratio of 1 : 2·4 : 5·76, which gives a factor of 2·4 for each rise of 10° C. (See Fig. 5, Division.)

Now we are told by the investigators that at 35° C. Chilomonas is on the point of succumbing to the heat, so that the division rate increases right up to the death point, with no sign of an optimum effect. Below 14° C. no observations are recorded.

Here, then, we have throughout the whole range exactly the same primary temperature relation exhibited by the protoplasmic procedure that we should expect for a chemical reaction in a test-tube.

This division phase is only a part of the life-cycle of the flagellate, and between division it swims about anabolising the food material of the medium and growing to its full size ready for the next division. One wishes at once to know what is the effect of the temperature upon the length of the life-cycle. Is the whole rate of metabolism quickened in the same way as the particular section concerned with actual division? Of course a motile flagellate cannot be followed and its life-cycle directly timed, but the information was obtained by estimating carefully what percentage of individuals was in a state of actual division at each temperature. It was found that always 4 per cent. were dividing, whatever the temperature. This proves that the whole life-cycle is shortened in exactly the same proportion as the process of division at each temperature, and that it is just twenty-five times as long. Therefore the life-cycle is 125 mins. at 35° C. and 725 mins. at 15° C., so that here, again, we have the physical-chemical relation with a factor of 2·4 for each rise of 10° C.

In this paper of Maltaux and Massart these relations are not considered as the manifestation of physical-chemical principles, but are regarded as reactions to stimuli; and the paper contains a number of experiments upon the effect of sudden changes of temperature upon the occurrence of division. So far as one can make out from inspection of the scattered literature, it does seem established that sudden changes of temperature act as stimuli in the strict sense of the word. In many investigations one finds it stated that a quick change of temperature produced a certain reaction which a slow change of temperature failed to evoke. Usually all the phenomena are treated in terms of stimulation, and the absence of reaction with slow change of temperature is regarded as secondary. Were it not for the specific stimulatory effects of quick change, which are not difficult to comprehend as a phenomenon *sui generis*, I hardly think so general a tacit acquiescence would have been extended by botanists to the view that all enduring changes of velocity of metabolism brought about by lasting changes of temperature are stimulatory in nature.

No determination of the rate of development of bacteria through a very wide range of temperature seems to have been made. There are various incidental experiments which indicate values about 2 for the coefficient of increase of metabolism for a rise of 10° C.

I am not acquainted with any data for the growth-rate of whole flowering plants at different temperatures. Of course the case of growth most usually measured in the laboratory, namely, where one part of a plant extends at the expense of the reserves stored in another part and there is a decrease, not an increase, of total dry weight, is not the type of growth we have to deal with. Even for simple elongation of a shoot at different temperatures we have but few data. Those of Koppen (1870) generally quoted are wildly irregular, and in many cases it is clear that the growth-extension of complex structures is a process which proceeds by spasms rather than smoothly.

The rate of movement of circulating protoplasm increases rapidly with temperature, but Velten's numbers do not give an obvious logarithmic curve. If we confine our attention to the values for 29° C. and 9° C. we do find, however, that the velocity increases about two-fold for each rise of 10° C., being 10 mm. at 9° C. and 40 mm. at 29° C.

Taken altogether these various data clearly support the hypothesis that temperature accelerates vital processes in the same way as it does non-vital chemical reactions, that is, logarithmically by an approximately constant factor for each rise of 10° C.; and, further, it accelerates them to the same extent; that is, that the factor in question has values clustering about 2–3.[1]

To make these similarities more significant I ought to point out that no other properties of matter are accelerated to anything like this extent by rise of temperature. Most reactions increase in velocity by no less than 10 per cent. per degree rise of temperature; a most marked effect, and yet there is no generally accepted explanation of this almost universal phenomenon. By the kinetic theory of gases each rise of a degree in temperature increases the movements of the gas-molecules, so that the number of collisions between them is greater, but only about one-sixth per cent. greater. With rise in temperature, too, the viscosity of a solution diminishes, so that there is less resistance to internal changes; but this only to the extent of 2 per cent. per degree. The degree of ionisation also increases, but only extremely little, so that no change of known physical properties will explain the phenomenon. Various hypotheses which need not detain us have been put forward.

Unexplained though it may be, yet the quantitative treatment of the subject is clear enough and, I think, as cogent in the living organism as in the test-tube. If so, we may consider ourselves now justified in separating off from the realm of stimulation yet a third class of causal connection, namely, that between temperature and the general intensity of vital processes.

### Conclusion.

In this attempt to assert the inevitableness of the action of physical-chemical principles in the cell, I have not ventured upon even the rudiments of mathematical form, which would be required for a more precise inquiry. Biochemistry is indeed becoming added to the ever-increasing number of branches of knowledge of which Lord Bacon wrote: "Many parts of nature can neither be invented with sufficient subtilty, nor demonstrated with sufficient perspicuity, nor accommodated unto use with sufficient dexterity, without the aid and intervening of the mathematics."

In this sketch which I have had the honour of outlining before you I have critically considered but few points. I have rather endeavoured to distribute imperfect data in the perspective in which they appear from the point of view of one who seeks to simplify phenomena by extending the principles of chemical mechanics so far as possible into the domain of vital metabolism. Much critical quantitative work has yet to be done before the whole becomes an intelligible picture.

To me it seems impossible to avoid regarding the funda-

[1] Maltaux and Massart, *Recueil de l'Institut botanique Bruxelles*, tome vi., 1906.

[1] It has been proposed to use the size of the temperature coefficient to settle whether a process like the conduction of an impulse along a nerve is a chemical or a physical process. See Keith Lucas, *Journal of Physiology*, vol. xxxvii., June, 1908, p. 112.

mental processes of anabolism, katabolism, and growth as slow chemical reactions catalytically accelerated by protoplasm and inevitably accelerated by temperature. This soon follows if we once admit that the atoms and molecules concerned possess the same essential properties during their brief sojourn in the living nexus as they do before and after.

Perhaps the more real question is rather as to the importance and significance of this point of view. Protoplasmic activity might be something so much *per se*, and the other factors of the nature of stimuli might be superposed so thickly upon that substratum which should be dominated by simple principles of chemical mechanics that for practical purposes the operations of the latter would be so overlaid and masked as to be negligible. A survey of this field, however, seems to show that this is not so, and that the broad action of the law of mass and the acceleration of reaction-velocity by temperature are obviously responsible for wide ranges of phenomena.

Now the conception at the bottom of these principles is that of reaction-velocity, and the conclusion of the whole matter is that the physiologist must frankly take over from physical chemistry this fundamental conception.[1] Under definite conditions of supply of material and temperature there is a definite reaction-velocity for a given protoplasm, and the main factors that alter the rate of metabolism, viz., heat, nutrition, and traces of impurities are exactly the factors which affect the velocity of reactions *in vitro*.

Working on this basis we no longer need the vague unquantitative terminology of stimulation for the most fundamental of the observed "responses" to external conditions. Three sets of phenomena we have observed which, though usually treated in the category of stimulation, draw a clearer interpretation from the conception of reaction-velocity. These were: (1) the relation of development to the absence or deficit of single essential food constituents; (2) the occasional striking effect of minute traces of added foreign substances upon the whole rate of growth and metabolism; and (3) the general doubling of the activity of vital processes by a rise of 10° C.

The next higher stratum of principles should be the complications introduced by limiting factors which interrupt the extent of the manifestations of these principles and by various correlations, as, for example, that by which the reaction-velocity of one catabolic process might withdraw the supply of material needed for full activity of another different process. To this sort of relation may be attributed that phenomenon so characteristic of the more complex vital processes and quite unknown in the inorganic world, namely, the optimum.

Finally, superposed upon all this comes the first category of phenomena that we are content still to regard as stimulatory. From the point of view of metabolism and reaction-velocity many of these appear very trivial, though their biological importance may be immense. Think how little the tropistic curvatures of stems and roots affect our quantitative survey; yet a little re-arrangement of the distribution of growth on the two sides of an organ may make the difference between success and failure, between life and death.

From our present point of view vision does not extend to the misty conceptions of stimulation upon our horizon. We may therefore postpone speculation upon the mechanical principles governing them and await the time when by scientific operations we shall have reduced to law and order the intervening region, which we may entitle the chemical substratum of life. This done we may venture to pitch our laboratory a march nearer to the phenomena of protoplasmic irritability and make direct attack upon this dominating conception, the first formidable bulwark of vital territory.

[1] No general treatment of the physiology of plants has yet been attempted in terms of reaction-velocity. Czapek, however, in the introduction to his stupendous "Biochemie der Pflanzen," vol i., 1905, does direct attention to the conception of "reaction-velocity" and refer to the standard literature on this subject and on catalysis, though direct application is not made to the plant. Cohen ("Physical Chemistry for Physicians and Biologists," English edition, 1903) considers in detail some biological applications of the acceleration of reactions by temperature.

## THE SCIENTIFIC STUDY OF PLAGUE.

The fourth extra number of the *Journal of Hygiene*, containing the work of the Plague Commission, has appeared lately.[1] Chapter xxvi.—the first of this number—is a translation of a St. Petersburg thesis (1904) by Dr. Verjbitski, which has not been published before. The Russian worker arrived independently at conclusions, with regard to the transmission of plague by blood-sucking parasites, which tally well with those of the Indian workers. The common rat flea of Cronstadt, however, is *Typhlopsylla musculi*, and appears not to attack man. Experiments with bugs gave results similar to those with fleas.

Chapter xxvii. is the substance of a report submitted to the Indian Government by Lieut.-Colonel Bannerman and R. J. Kápadiâ in 1904. It shows that domestic animals (pigs, calves, fowls, turkeys, geese, and ducks) are not susceptible to a general infection with *B. pestis*, though local abscesses were sometimes produced by inoculation.

Chapter xxviii. gives some experiments on septicæmia in human plague, with others on the infectivity of excreta, supplementary to work detailed in an earlier number of these reports.

The most interesting portion of this number is contained in chapters xxix. to xxxi., dealing with the bionomics of fleas, the mechanism by means of which the flea clears itself of plague bacilli, and the seasonal prevalence of plague.

Simple and ingenious are the methods of carrying out flea experiments here described. The results, too, are interesting. It is found that fleas do not remain constantly on their host, but hop off on to the floor or into the nest of the rat. Here the eggs are laid, and, when the fleas seek food again, it is likely that a different rat will supply the meal. In this way the same flea may bite several rats in the course of the day, and forms a very efficient means of spreading infection. Not only this, but the experiments prove that, where many rat fleas are present (*P. cheopis*), some of them will readily attack man, though rats are at hand.

The developmental stages of the flea are passed through in three weeks in favourable circumstances. Temperature above 80° F. has a retarding influence, which becomes very marked between 85° F. and 90° F. At these temperatures fewer eggs are laid, and their development is slower than at lower temperatures such as 70° F.

Passing to the consideration of the seasonal prevalence of plague, we find that though climatic conditions go for something, yet they leave much to be explained. Charts are given which show the recurrent plague epidemics in six widely different localities, along with temperature and humidity curves. Humidity appears to have little importance. With regard to temperature, the following conclusions are drawn:—

(1) A plague epidemic is checked when the mean daily temperature passes above 80° F., and especially when it reaches 85° F. or 90° F.

(2) A mean temperature above 80° F. affects the conditions to which the plague bacillus is subjected in the stomach of the flea. At high temperatures, about 90° F., the plague bacilli disappear from the stomach of the flea much more quickly than at lower temperatures, namely, between 70° F. and 80° F.

(3) A plague epidemic may, however, come to an end when the temperature is most suitable. Other factors must therefore be present in these cases.

Reading further, we find these "other factors," tending to check an epidemic, are a diminution in the number of rat fleas, a diminution in the total number of rats, and an increase in the proportion of immune to susceptible rats. Perhaps the first of these factors is the least important; chart vii. shows that in Bombay, in 1907, the epizootics (in both *M. decumanus* and *M. rattus*), and even the epidemic, began to decline a month before the flea infestation showed any decrease.

The last two factors are consequences of the outbreak

[1] Reports on Plague Investigations in India. *Journal of Hygiene*, vol. viii., No. 2. Pp. 148; Charts vii. Cambridge: University Press, May, 1908.) Price 6s.

of plague itself, so that an epizootic has only to reach a certain intensity in order to bring about its own decline. It is difficult to estimate the decrease in rat population caused by an epizootic, but the systematic trapping carried out in the Punjab villages of Kasel and Dhand gave results which seem to indicate that this decrease may be considerable. An increase in the proportion of immune rats has a double action. First, it obviously connotes a decrease in the available number of susceptible rats; secondly, these immune rats actually protect their susceptible companions. For consider an infected flea which has just left a rat dead of plague. Such a flea is dangerous only so long as he carries living plague bacilli in his stomach. But the Commission has shown that the destruction of plague bacilli within the flea's stomach is largely effected by the activity of the rat's leucocytes, taken in at each fresh meal. But efficient phagocytosis depends on efficient opsonisation, so that if the infective flea chances to take a meal from an immune rat, the opsonic power of the blood of which is generally above normal, the phagocytic process will be hastened, and the flea will be less dangerous to his next susceptible host. This deduction was tested in an experiment in which fleas were first infected and then fed for twenty-four hours, one series on immune rats and another series on susceptible rats. The two lots of fleas were then allowed to feed on normal guinea-pigs, of which the immune-fed fleas infected only four out of eleven, while the others infected eight out of eleven. But we are led to expect further experiments on this interesting topic.

The number concludes with some brief remarks of the differential diagnosis of *B. pestis*. L. Noon.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

London.—A course of eight lectures on "Algal Flagellates and the Lines of Algal Descent" will be begun by Dr. F. E. Fritsch at University College on October 26. During the second term a course of eight lectures on "Physical Chemistry and its Bearing on Biology" will be delivered by Dr. J. C. Philip, and in the third term a course of eight lectures on "Recent Advances in the Study of Heredity" will be delivered by Mr. A. D. Darbishire. A course of four lectures on "The Geological Structure of the Area of the Vosges" will be delivered at Bedford College by Miss C. A. Raisin, beginning on November 16, and in the second and third terms courses will be given at University College by Dr. A. Smith Woodward, F.R.S., and Prof. E. J. Garwood on, respectively, "The Use of Fossil Vertebrata in Stratigraphical Geology" and "The Geology and Physiography of Arctic Europe." Beginning on January 22, Dr. W. N. Shaw, F.R.S., will give a course of lectures on "The Climates of the British Possessions." On October 20 Dr. F. S. Locke will deliver, in the physiological laboratory of the University, a course of lectures on "Some Problems of General Physiology, more Particularly those Associated with Muscle," and in the second and third terms courses will be given by Prof. A. D. Waller, F.R.S., and Dr. A. Harden on, respectively, "General Physiology of Nerve" and "Chemical Biology of the Yeast Cell." On February 2 Dr. L. C. Parkes will begin, at University College, a course of four lectures on "The Medical Aspects of Recent Advances in Hygiene as Connected with Sewering." Prof. E. A. Minchin will in the third term give, at the Lister Institute, a course of lectures on protozoology, and in the first term Mr. R. Lydekker, F.R.S., will deliver three lectures on "The Living and Extinct Faunas of Africa and South America." Details as to the time and place of the delivery of the last-named course will be announced later. All the lectures referred to will be addressed to advanced students, and no charge will be made for admission.

*University College.*—The delivery of the following introductory public science lectures has been arranged for:—October 6, "Davy and Graham," by Sir William Ramsay, K.C.B., F.R.S.; October 8, "Personal Religion in Egypt," by Prof. W. M. Flinders Petrie, F.R.S.; October 8, "Gleanings in the Babylonian East," by Dr. T. G. Pinches; October 9, "Recent Developments in Philosophic Thought," by Prof. G. Dawes Hicks; October 9, "School Hygiene," by Prof. H. R. Kenwood; October 14, "The Scientific Principles of Radio-telegraphy," by Prof. J. A. Fleming, F.R.S.

*Bedford College.*—A course of lectures and demonstrations for teachers, and persons qualifying to be teachers, will be given on "The Hygiene of Common Life," by Dr. J. S. Edkins. The opening lecture (the admission to which will be free) will be delivered on October 13.

Oxford.—In a Convocation to be held on October 8 it will be proposed to confer the degree of Doctor of Science, *honoris causa*, upon Dr. Svante August Arrhenius and Dr. A. G. Vernon Harcourt, F.R.S.

Mr. Matthew Monie has been appointed lecturer on geology at the Glasgow Agricultural College.

Dr. H. Byron Heywood has been appointed assistant lecturer in the mathematical department of the East London College.

The general prospectus of the day and evening classes to be held at the Battersea Polytechnic during the session which has just begun provides careful guidance for intending students. New classes have been arranged for advanced students in hygiene, geology, and bacteriology, and new trade classes in wheelwrights' work and gas-fitting have been inaugurated. It is satisfactory also to find that coordinated courses have been drawn up in engineering, chemistry, physics, mathematics, and other main branches of work. A building grant from the London County Council has made it possible to set about extending the laboratories for mechanical and electrical engineering, and to undertake extensive alterations and additions in the chemistry department.

The Board of Education has issued the following list of candidates successful in the competition for the Whitworth scholarships and exhibitions, 1908:—*I. Scholarships* (125*l.* a year each, tenable for three years): W. H. Mead, Southsea; W. White, Portsmouth; W. H. Stock, Swindon; E. Bate, London. *II. Exhibitions* (50*l.*, tenable for one year): A. H. Gabb, Swindon; A. McKenzie, Devonport; R. Bassett, Devonport; S. L. Dawe, Devonport; A. J. Triggs, Devonport; A. C. Lowe, Harrogate; J. R. Pike, Portsmouth; H. R. Allison, Gillingham; A. E. Beal, Sheerness; C. R. Kemp, London; H. L. Guy, Penarth, Glamorgan; H. G. Stephens, Leicester; F. E. Rowett, Chatham; C. E. Haddy, Torpoint, R.S.O., Cornwall; W. E. Tong, Gosport; G. W. Bird, Plymouth; C. W. Limbourne, Plumstead; W. G. Pitt, Plumstead; E. J. Cox, Gosport; G. H. Reid, Stonehouse, Devon; D. Watson, Swindon; J. E. Burkhardt, Newcastle-on-Tyne; P. R. Higson, London; A. J. Sear, Portsmouth; E. O. Hale, Stantonbury, Bucks; F. C. Ham, Plumstead; A. R. C. Winn, Hornchurch, Essex; J. Scobie, London; F. Bray, Devonport; C. P. T. Lipscomb, Plumstead.

The second section of the new buildings of the Glasgow and West of Scotland Technical College was used for the first time on Tuesday, September 22, on the occasion of admitting to the associateship of the college the students who had gained the college diploma at the close of last session. Dr. G. T. Beilby, F.R.S., chairman of the governors, presided at the meeting held in the examination hall, and in the course of an address described the relations of the college to the reform in methods of coal consumption. The college was the first institution in the United Kingdom to establish special laboratories for the teaching and study of everything connected with fuel and combustion. The most recent knowledge on these subjects shows that in the great majority of cases smoke and dust are quite unnecessary concomitants of industry. The inquiries of the recent Royal Commission on Coal Supplies have made it abundantly clear that the present inefficient consumption of coal in Great Britain not only leads to the waste of from forty to sixty million tons per annum, but that this inefficiency is also responsible for the greater proportion of the smoke and dirt from which the nation suffers. It has been estimated that on the total British consumption 30 per cent. might be saved if the best-known means of consumption for each purpose were employed. The college has as its most obvious duty the education of specialists for the particular branches of industry which prevail in the district; but at the foundation of these industries there is one fundamental factor which affects each and all of them—they all depend ultimately on the combustion of coal for the production of light, heat, and power. Since the special laboratories were opened in connection with the Young chair of chemistry, Prof. Thomas Gray has carried out systematic instruction on the methods used for the scientific control of the combustion of coal and the economical utilisation of heat in factories. Not only are the regular students of chemistry, metallurgy, and engineering instructed in these methods as a necessary part of their curriculum, but similar instruction has been sought for and obtained by the members of the staff of a number of leading industrial concerns in the district.

## SOCIETIES AND ACADEMIES.

LONDON.

**Royal Society**, June 4.—"The Viscosity of Ice." By R. M. **Deeley.** Communicated by Henry Woodward, F.R.S.

The rate of motion of a number of glaciers has been determined by Tyndall. From his figures and estimates of their thickness and slope it is possible to calculate with some degree of accuracy the viscosity of several glaciers. Stated in dynes per square centimetre $\times 10^{12}$, the results are roughly as follow:—the Mer de Glace, 27; Morteratsch, 143; Lower Grindelwald, 3; and Great Aletsch, 126. It seems probable that these differences arise mainly from differences in the actual viscosity of the glacier ice due to its varying granular structure. It is shown that the viscous flow of a glacier exercises a drag on the floor upon which it rests amounting in the case of the Great Aletsch to about $2\frac{1}{2}$ tons per square foot, and that owing to the ability of the ice to transmit thrust, this force may be greatly exceeded at points where much resistance to motion is caused by inequalities in the floor upon which the ice rests.

McConnel made a number of experiments on the shearing motion which can be produced in ice crystals in directions at right angles to the optic axis. It is shown that this shear obeys the laws of viscous motion, and that the viscosity may be expressed by the following equation:—

$$\log_{10}\mu = 0{\cdot}301 + 153t - 0{\cdot}00231t^2,$$

where $\mu$ is the viscosity in dynes per square centimetre $\times 10^{10}$, and $t$ is the temperature below zero C. (considered positive). McConnel showed that when the load was taken off a bar of ice which had been yielding viscously, there was a slow partial recovery of the original form. Experiments with highly brittle pitch also showed that when the load was taken off a weighted bar there was an immediate elastic recovery, and also an additional slow recovery. This feature has also been described by Trouton.

The viscosity of ice at right angles to the optic axis is about 6250 times less than that of a glacier; the optic axis of glacier grains being at all angles, they lock each other. The motion of a glacier is due in a large measure to changes in the sizes and shapes of the glacier grains due to their growth and decay.

PARIS.

**Academy of Sciences**, September 21.—M. Bouchard in the chair.—The determination of the triple orthogonal systems which comprise a family of cyclids, and, more generally, a family of surfaces with lines of curvature plane in the two systems: Gaston **Darboux.**—The use of tartar emetic in the treatment of trypanosomiasis: A. **Laveran.** Guinea-pigs infected with *T. evansi*, *T. gambiense*, and the trypanosome of Togo, were treated with hypodermic injections of a solution of sodium antimonyl tartrate in 2 per cent. solution. The results were generally favourable, especially when the antimony salt was used in conjunction with atoxyl.—The impossibility of demonstrating the existence of an appreciable dispersion of light in interstellar space by the Nordmann-Tikhoff method: Pierre **Lebedew.** The ratio of the dispersion values found by Nordmann and by Tikhoff is 30 : 1, and the author concludes that a method of measurement which gives such different values for the same physical constant must be false in principle.—The spectra of the large planets photographed in 1907 at the Flagstaff Observatory: Percival **Lowell.** The principal lines and bands observed for Jupiter, Saturn, Uranus, and Neptune are tabulated. The presence of water vapour in the atmospheres of Jupiter and Saturn is proved, and also free hydrogen in Uranus and Neptune.—Reciprocal differences: E. **Nörlund.**—A lecture experiment concerning the rotation of the earth: Louis **Maillard.**—A particular form to which the differential equations of the trajectories of electrified corpuscles in a magnetic field can be reduced: C. **Störmer.**—The origin of the Brownian motion: Jean **Perrin.** Further experiments are described confirming the hypothesis that molecular agitation is the cause of the movement.—The thermoelectricity of cobalt: H. **Pécheux.** A study of a copper-cobalt thermocouple shows that molecular transformations occur in cobalt at 280° C. and 550° C.—Oleuropine, a new principle of glucoside nature extracted from the olive (*Olea europea*): Em. **Bourquelot** and J. **Vintilesco.**—The function of the nervous system in the changes of colour in the frog: E. **Sollaud.**—The supposed action of tobacco in producing abortion: R. **Robinson.** Evidence is adduced negativing this supposed action.—The cause of magnetic storms: K. **Birkeland.**

## CONTENTS.

THURSDAY, OCTOBER 8, 1908.

## SUPERHEATERS.

*Superheat, Superheating, and their Control.* By William H. Booth. Pp. xv+155. (London: A. Constable and Co., Ltd., 1907.) Price 6s. net.

THE constant reiteration of one maker's name in the book before us is wearisome, and we are agreed that "Connected as the author is with the only type of superheater using water-control in inner tubes he is not unnaturally apt to favour that system somewhat" (p. 143). He does this to the extent of twenty-two full pages of illustrations, &c., out of the 155 composing the book, besides further references on nine more!

The author thinks regulation of the temperature of the steam most important, and mentions seven ways of accomplishing this end. Prof. Unwin, however, has expressed scepticism as to this necessity "*provided only the superheaters were properly placed*"; an opinion in which he was supported by the late Mr. Bryan Donkin.[1]

The author considers Lancashire and similar boilers suitable for combining with superheaters, but for "average water-tube boilers," whatever this may mean, and marine boilers he recommends separately fired superheaters.

The inventor of one of the most widely used superheaters, especially for locomotive work, is referred to as "one Schmidt," and *two* locomotives are stated to have been fitted with his system with good results! While crediting another system with having been fitted or ordered for 372 locomotives, he gives no description. Describing another in some detail, he says nothing of its performance, or, indeed, whether it is in use. Only two other superheaters are illustrated. Particulars of two tests only are given, made with "Cruse" and "Foster" superheaters respectively.

Although he works out the area of a "theoretical diagram" to one ten-thousandth of a square inch (!) the author is less particular about other matters. For instance, the specific heats of several of the substances in a table on p. 8 do not agree with those on p. 148. In a curious calculation on p. 16 he concludes that a pound of steam at 361° F. will raise 60 pounds of cast iron from 62° to 361°. Taking the value of the specific heat of cast iron =0·11, as given on this page (two other values are given elsewhere), 1973 B.Th.U.[2] are required to effect this. As each pound of steam can only supply 1192 B.Th.U., even if cooled to 32°, the author expects to get more heat out of the steam than it contains.

In attacking what he calls "The Leakage School" he is apparently unaware that serious leakage is usually only attributed to engines with flat slide valves; and not, therefore, to those designed for use with superheated steam. Captain Sankey has demonstrated in a masterly manner that properly designed piston valves are practically steam-tight.

On p. 29 the well-known expression $PV^{1\cdot065}$ is printed $PS^{1\cdot065}$; an unfortunate departure, as "S" has another meaning on p. 33. Another loose expression is the use of the term "thermometric" heat for a quantity measured in B.Th.U.

On p. 34, the first equation is hopelessly wrong. A formula at the bottom of the same page, for converting the actual evaporation of a boiler to its equivalent weight of water "from and at 212," is only correct if the steam is saturated and dry; yet we read on p. 46 "No boiler delivers dry steam."

Notwithstanding the author's statement that he "prefers not to write a book of the catalogue-compilation type," he has, in our opinion, failed to give any information which would be useful to a designer, or, indeed, to anyone but a prospective customer.

The publishers have produced the book in their usual excellent style, but there are one or two instances of American spelling which have apparently escaped the reader's notice.

[1] Proc. Inst. Mech. Engineers, 1896.
[2] $(0\cdot361° - 62°) \times 0\cdot11 \times 60 = 1973$.

## A BAVARIAN TEXT-BOOK OF BOTANY.

*Lehrbuch der Botanik für Oberrealschulen und Realschulen.* By Dr. Th. Bokorny. I. Teil. Pp. vi+366. Price 4 marks. II. Teil. Pp. 223. Price 3 marks. (Leipzig: W. Engelmann, 1908.)

A REDEEMING feature of the large number of botanical text-books published during the last few years has been the freshness, in some cases the originality, of treatment which has from time to time characterised them. The volumes now under notice constitute a case in point. The reorganisation and extension of botanical teaching in the Realschulen and Oberrealschulen of Bavaria has rendered the existing text-books unsuited to the changed ideas, and in the present volumes Prof. Bokorny has produced a text-book which aims at directing, upon right lines, the efforts of those entrusted with the new teaching.

The author's treatment of his subject is of some interest to teaching botanists. The first section of part i., occupying nearly one-half of the volume, is concerned with a description, in almost non-technical but very direct language, of representative plant species from the phanerogams downwards, the flowering plants receiving by far the greatest attention. At convenient intervals in these descriptions the author deals with a topic of special interest—not necessarily bearing upon the preceding subject-matter—particular examples being the influence of soil conditions upon plant life, the relationships between plants and insects in the pollination processes, distribution of fruits and seeds, and the influence of light upon plant growth. An almost inevitable accompaniment of this system is a certain discontinuity of text which is occasionally striking, but there can be little doubt that the method should quickly arouse the interest of the student, and found it, from the beginning, upon an extended basis. The plants chosen for description are invariably such as should be familiar to students who are no longer beginners, and a welcome departure from established custom is the inclusion of plants of economic importance. The descriptions are largely concerned with floral characters, and are brief and well-written.

The first section of the book, together with an out-

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line of the essential points of plant anatomy and histology, may be regarded as preparatory to the more serious systematic study of the vegetable kingdom contained in section iii. As might be expected, Prof. Bokorny has adopted the Englerian scheme of classification, but reference is made to other systems, the Linnean system being considered, in a special chapter, at greater length perhaps than is desirable at the present day. The greater part of the section is devoted to the principal orders of phanerogams; and in his emphasis of well-chosen points of taxonomic importance and frequent references to plants of economic and biological interest, the author has produced a very clear and readable exposition of a branch of botany notoriously difficult to deal with in a manner which shall arouse and, more especially, sustain the interest of the student.

The question of general morphology is dealt with in the first section of part ii. Both the stage at which this important branch of botany is considered and the relatively small amount of space allotted to it—some twenty pages largely occupied by illustrations—would probably meet with criticism at the hands of most English botanists, and the same may be said with regard to the comparatively little attention paid to anatomy. But the principal features of part ii. are the sections dealing with physiology and ecology. In the latter section the author prefers the primary title of "Biologie der Pflanzen"; the various factors influencing plant life are first considered in some detail, and the actual studies of typical formations are concerned with the vegetation of the earth as a whole rather than with a detailed consideration of more restricted areas, a method more generally adopted in this country.

A feature of the book is the wealth of illustrations with which it is provided. Most of them are familiar friends, but they are drawn from very varied sources, and the inclusion of many of them is a further example of the freshness of conception which has been already commented upon as characterising these volumes.

## OUR BOOK SHELF.

*Dæmringen i Norge.* By Prof. H. Mohn. Pp. 76. (Christiania: Jacob Dybwad, 1908.)

IN a country which stretches, as Dr. Mohn reminds us, to the 71st degree of north latitude, the times of sunrise and sunset, with the accompanying phenomena of twilight, have a wider significance than with us. There the calendar has to be consulted to find the day when the sun will first appear above the horizon, while the amount of light received when the sun is a definite distance below the horizon has a distinct economic value. Even the azimuth at which the sun will rise or set is not altogether a negligible quantity. Considerations of this kind have led Prof. Mohn to submit the question of twilight to a very close investigation, and to furnish tables which will enable an inhabitant of these northern regions to gauge very accurately how much direct or reflected sunlight he may expect. No doubt Prof. Mohn is well advised from a practical point of view, but in some respects his tables seem to aim at a greater degree of accuracy than can be of service. In such questions as the effect of temperature on refraction, or the amount of reflected light, the variables arising from clouds and state of the sky generally would upset the nicety of the calculations. But so far as the convenience of the tables is concerned, and the thoroughness with which the theory is presented, there is nothing left to be desired, and it is not surprising if those who have not lived in a country where the economy of the winter light is a matter of importance fail to appreciate the necessity of this accuracy.

Prof. Mohn recognises four distinct steps in the approach of night or dawn. (1) The true time of geometrical sunrise or sunset when the sun's upper limb is on the astronomical horizon, or $Z_1 = 90° + r - \pi + \rho$, where $\rho$ is the refraction, $r$ the sun's radius, and $\pi$ the parallax. (2) The beginning and end of the gloaming (Skumringens Ende), when the sun's centre is 4° below the horizon. In clear weather in Norway, indoor work is possible under these conditions. Bright stars begin to appear in the sky. Sirius is visible when the sun is three degrees below the horizon. (3) It is more difficult to understand what is meant by the end of twilight. It is the time when daylight decreases most rapidly, and is described as the time when, in a clear sky, print can be read with difficulty if the light from the illuminated part of the sky is allowed to fall on the page, or when some kinds of outside work may be carried on. As a matter of computation, the time is decided by increasing the zenith distance of the sun, given in the first case by small angles depending on the atmospheric refraction, making the sun's zenith distance about 98°. (4) The last stage is that of complete night, or the time when the earth's atmosphere receives no light from the sun. The sun is then about 17° below the horizon. This scheme is a great practical advance on the method adopted in this country, where an arbitrary zenith distance of 108° is accepted as that at which night begins or ends. Tables are given for extending the calculations to other latitudes, and would make them available in the Shetland Isles and North Scotland.

*Maryland Weather Service.* Vol. ii. 1907. Pp. 515; illustrated. (Baltimore: The Johns Hopkins Press, 1907.)

THIS volume contains a report on the climate and weather of Baltimore and vicinity, prepared by Dr. O. L. Fassig under the direction of Prof. W. L. Moore, chief of the United States Weather Bureau; it is based on observations of the latter service since 1871, supplemented by all available records, both public and private, extending over a period of nearly a century. Meteorologists owe a debt of gratitude to the board of control of the Maryland Weather Service, and to Dr. Fassig especially, for one of the most complete and valuable meteorological discussions extant. Part i., which occupies more than half the volume, deals with climatic factors, each element being considered, so far as possible, with reference to its annual and diurnal periods and its variability; the statistical tables are supplemented by the usual range diagrams and also by isopleths, the principle of which was devised many years ago by M. Léon Lalanne. Although not frequently employed, the latter method exhibits in a concise and intelligent way the successive changes throughout the year. The value of this section of the work is much enhanced by careful discussion of the results obtained and of the interaction of the various elements, by references to the present state of our knowledge and to generally accepted theories.

Part ii. deals with actual weather conditions, with cold and warm waves, and types of weather, illustrated by beautifully executed synchronous charts. The discussions, which will be of the utmost interest to the students of practical meteorology, direct especial attention to the relation between wind-direction and temperature, the distribution of clouds, rainfall, &c. The author makes use of the long series of data at his disposal to test several points of popular interest. The temperature observations, extending over a period of eighty-seven years, do not exhibit any tendency to the cold period about May 10–13 which is observed in Europe; on the contrary, there is a distinct rise, probably due to high barometric pressure at this time over the southern Atlantic States. Nor do they show any regular recurrence of cold and warm periods; the only negative conclusion that the author considers may be safely drawn is that a cold winter is not likely to be followed by a warm spring or summer, and that a warm winter is not likely to be followed by a cold spring or summer. The observations clearly disprove the popular belief in the occurrence of severe storms at the equinoctial periods of March and September, while a comparison of weather conditions with the sun-spot curves neither proves nor disproves any intimate relation. We congratulate the author on the able way in which he has dealt with the whole subject, without having had recourse to mathematical formulæ.

*A Monograph of the Silurian and Devonian Corals of New South Wales.* Part ii. By R. Etheridge, jun. (Sydney, 1907.)

THIS part deals with the genus Tryplasma, of which several new species are described, from the Upper Silurian of the neighbourhood of Yass. A history of the genus is given, together with an account of its relations to other genera and its systematic position. Attention is directed to the intimate relation existing between the structure of Lindström's Pholidophyllum and that of Tryplasma, but in none of the Australian species of the latter have been found any of the exothecal scales which led Lindström to consider *Pholidophyllum tubulatum* (Schloth.) homologous in a certain sense with Calceola, Goniophyllum, and Rhizophyllum. The author advocates the removal of *Ph. tubulatum*, as a representative Tryplasma, from the vicinity of the *Anthozoa operculata* to a separate family, the Tryplasmidæ, with relations to Amplexus and Pycnostylus. The general structure of the Australian Tryplasmidæ is described in detail, but the examination of the development of the septal lamellæ and spines by means of serial sections was not attempted.

*The Fauna of British India, including Ceylon and Burma.* Published under the authority of the Secretary of State for India in Council. Edited by Lt.-Col. C. T. Bingham. Rhynchota. Vol. iv., part ii. Homoptera and Appendix (Part i.) By W. L. Distant. (London: Taylor and Francis, 1908.) Price 10*s*.

WE congratulate the editor and author on the appearance of another half-volume of this important work. The present instalment is devoted to the homopterous family Jassidæ, subfam. v. Jassinæ (including Acocephalinæ), comprising twelve divisions, and subfam. Typhlocybinæ, with two divisions. The species included are numbered from 2509 to 2696. An appendix is commenced, including additions to the Rhynchota Heteroptera discussed in vol. i.; and the portion now published relates to the families Pentatomidæ, Coreidæ, and Berytidæ, and the additional species are numbered from 2697 to 2768. The general character of "The Fauna of British India" is so well known, and has been so frequently commented on, that it is only necessary to say that the present half-volume is similar to those which have preceded it, and that the high character of the series is fully maintained.

*How we Travel. A Geographical Reader.* By J. F. Chamberlain. Pp. ix+227. (New York: The Macmillan Co., 1908.) Price 2*s*. 6*d*.

THE intention of the author of the series of four reading books, of which this is the last, is to develop an interest in the subject on the part of young pupils beginning the study of geography. The little book should be popular in the lower classes of secondary schools; it provides a simple, entertaining, and attractively illustrated account of means of travel and communication in various parts of the world. Previous volumes have dealt with man's activities connected with securing food, clothing, and shelter.

## LETTERS TO THE EDITOR.

*[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.]*

### Solar Vortices and Magnetic Fields.

SEVERAL weeks ago I discussed with Prof. Hale the matter of solar vortices and magnetic fields, with reference to his recent discoveries, briefly described in NATURE for August 20 (p. 368). It did not seem to me probable that the effects could be accounted for by unequal diffusivity of the positive and negative ions, or by centrifugal separation, nor does it seem necessary to assume, with Prof. Zeeman, that the magnetic effects are due to electrons participating in the vortical motion. Since that time I have recalled that, so far as definite evidence goes, *all luminous vapours giving a line spectrum, and therefore capable of showing the Zeeman effect, are positively charged.* A flame coloured with sodium or lithium vapour and placed between two condenser plates is attracted by the negative plate. This fact was used by Lenard to determine the velocity of the positive ions. As shown by Riecke and Stark (*Phys. Zeit.*, v., 537, 1904), if a sodium or lithium salt is placed on the kathode of a long spark the coloured vapour remains in that neighbourhood; if placed on the anode it is at once projected across the entire length of the gap. Hemsalech (*Comptes rendus*, cxlii., 2, 1906) proved spectroscopically that the metallic vapour in the spark is projected solely from the positive electrode. As shown by Stark (*Ann. der Phys.*, xiv., 529, 1904), that part of the luminous vapour in a mercury arc which gives a band spectrum is unaffected by an electric field, while that part which gives a line spectrum is positively charged. The canal and anode rays are likewise examples of positively charged carriers giving a line spectrum.

What becomes of the negative electricity in these cases is obscure; but the fact remains that somehow, either in the form of projected electrons or more rapidly moving negative ions, it gets away, and leaves behind the positively charged ions of the luminous vapour. If such is the case on the earth, we should expect it to be true of the luminous vapours of hydrogen, calcium, and other elements on the sun. Whether the vapours taking part in the sun-spot vortices are positively charged can easily be determined from Prof. Hale's observations on the Zeeman effect.

It would be interesting to know whether the solar vortices follow a definite cyclonic law, as is the case in the earth's atmosphere. If so, a definite resultant polarity should be produced by the aggregate of sun-spots, and accompanying magnetic fluctuations on the earth should be always in one direction. If the vortices are accidental the terrestrial effects should be irregular.

This line of thought raises questions as to the effect of the enormous mass of positive luminous vapours participating in the solar rotation. Will it give rise to magnetic effects? Perhaps not if ether is dragged with the sun; at any rate, a charged body rotating with the earth seems to produce no magnetic field. If, however, there are solar atmospheric currents on a large scale magnetic effects may be expected. If the sun is thus magnetised it would act inductively on the earth, and the magnetism of the earth might be thus accounted for. The sun's north pole should be positive to account for the negative polarity of the earth's geographic pole, and it is interesting to note that such would be the case if the sun's polarity is due to positively charged vapour rotating with it.

It would likewise follow that the moon is an induced magnet. It might be worth while for someone to consider the effects upon perturbations of earth and moon of the force moments due to the non-coincidence of the polar and magnetic axes.

If the supposed positive charges in the chromosphere arise from the projection of electrons into space, the accumulation of the latter in outer regions would produce with the positive atmosphere an enormous electrical double layer, with a radial field which would restrain further travel of the electrons and perhaps cause the tremendous outbursts of luminous positively charged vapour shown in prominences. Magnetic effects in these prominences should be looked for.

Very light ions (perhaps of some lighter element than any we know) might be drawn from the sun by the electric field, and their subsequent neutralisation by electrons may give rise to coronal line radiation. These encounters, always taking place in radial lines, may give rise to partially polarised radiation, but it must be confessed that it seems difficult to reconcile the effects which would probably follow with the observed direction of vibration in coronal light. E. Percival Lewis.

University of California, September 14.

## Memory in the Germ-plasm.

It has recently been suggested that acquired characters are transmitted by a kind of memory in the germ-plasm. If this suggestion were adopted, would it not enable us to explain the non-transmission of mutilations?

If there be such a connection between the somatic-cells and the germ-cells as this new theory presupposes, that connection must be constant. We must suppose the germ-cells to be a kind of registry in which all the events of the somatic life are recorded. Many of the records would be evanescent, just as many of the records in consciousness are evanescent, but important somatic changes would (by the accumulation of impressions) produce perduring records, and these would be the biological ground of the transmission of those changes to the new generation.

Now consider what happens in mutilation. A lamb's tail is shortened—what is the result in germ-memory? Merely the record of a momentary cut. Why should this be transmitted? There is already in the germ-memory the record of an undiminished tail—a record produced by thousands of impressions accumulated through every moment of the animal's earlier life. Naturally, this record will be prepotent over the record of a momentary event.

We must remember, too, that the nerves and muscles of a stump often strangely preserve for a long time what may almost be called a recollection of the amputated part. If the lost limb thus perpetuate itself (so to speak) in consciousness, it seems probable, *ex hypothesi*, that it similarly perpetuates itself in germ-memory. Moreover, a man who has lost a leg constantly tries (consciously or subconsciously) to act as though he still had it. This, again, one may suppose, would tend to perpetuate the germ-record of the lost member.

It seems, then, that, in a case of mutilation, the record in germ-memory of the momentary act of mutilation would be an evanescent record, and the germ-record, as a whole, would continue to be the record of an unmutilated body. Does not this help us to understand the non-transmission of mutilations? Hakluyt Egerton.

## Models of Plane and Spherical Waves.

It is very easy to form a mental picture of the displacements in an isotropic elastic solid transmitting a plane transverse wave. Alternate planes of constant phase are sheared relatively to one another, as explained in Schuster's "Optics," § 12. If this be a correct representation of the process of transmission, it should be possible to apply a similar method to the alternate spherical shells in the transmission of a spherical wave. The shears must obviously possess symmetry about the point centre of the disturbance, since the waves are transmitted uniformly in every direction. This appears to me to be impossible; but if such shears are impossible in a spherical wave it is absurd to apply them to a particular case of the spherical wave, viz. a plane wave. Will some kind friend please explain? J. J. D.

The following explanation may be helpful if I understand the difficulty aright.

Imagine a number of concentric spherical shells like the layers of an onion. Imagine the inside shell rotated about a diameter through a small angle, and imagine this displacement taken up in succession by the next shell, the next but one, and so on. Then we have a disturbance radiating outwards from the centre, but the wave motion is *not* symmetrical about the centre. If, however, we go to a long distance from the inside sphere along a perpendicular diameter we get *practically* plane waves.

But these plane waves are in no way the limiting case of spherical waves *symmetrical about a point*, for the vibrations take place in a particular direction (in other words, they are plane polarised). It is impossible to have shears in *plane* waves which possess the symmetry referred to by your correspondent. A pack of cards can be sheared parallel to its longer or shorter side or to its diagonal, but it cannot be sheared at the same time equally in all directions. There is no difference between plane and spherical waves in this respect. Light spreading out uniformly from a source is a very different thing from these simple plane and spherical waves. It represents a jumble of waves sent out from a large number of molecules, and these molecules are not only moving about and changing their positions, but are themselves rotating. The radiations they emit are probably different from the motions of the spherical shells described above, but these do by way of illustration. G. H. B.

## The Pendulation Theory.

In Nature of April 2, 1908, the reviewer of my "Pendulationstheorie," Mr. R. L., directed attention to the map which shows the distribution of the ichthyosaurs, because I have left out the African ones. He therefore thinks it difficult to commit himself to an opinion on the theory.

Those ichthyosaurs in Africa (not yet marked in the edition of Zittel's "Palæontology" I have used) are not in the least an argument against my theory, but give me another most striking proof of it. I had shown that the ichthyosaurs had taken their origin under the pendulation circle, and had wandered from there on the usual line south-eastward to New Zealand. For they have been found under the pendulation circle from Spitsbergen to Sicily, all the others on a line from Europe to New Zealand.

Their having been found in Africa only enlarges their extension along the pendulation circle, and so confirms my opinion that the ichthyosaurs have here taken their origin.

Another instance, quite recently discovered, offers the fluviatile medusa Limnocodium. Until recently it was only known in aquariums; it was first found in England, and described by Lankester. Its occurrence together with *Victoria regia* proves that its origin is in the tropical parts of America. Some time ago Prof. Oka described a second species from the upper Yang-tse-kiang. That is just the same discontinuous occurrence which I have pointed out, for instance, for the alligators, and which I have made use of for the pendulation theory. H. Simroth.

Leipzig, Gautzsch, August 21.

## SURVEYING FOR ARCHÆOLOGISTS.[1]

### V.

*Why the Measurement of Altitude is Necessary.*

It is now time to enter more into detail on a point to which reference has already been made, as it is one of great importance to all British archæologists, as Britain lies in a mid-latitude. If a star or the sun did not rise or set every day in Britain as happens at the poles, or rose and set vertically, as happens at the equator, the height of the horizon would not come into play.

As a matter of fact, however, in Britain some celestial bodies do rise and set, and *not* vertically; their paths, as we have seen, are inclined to the horizon, and therefore the azimuth of the rising or setting place depends upon the height of the horizon, and I may add that the zenith distance must be less than 90° if the horizon is raised by hills.

In order to consider this matter more closely, I give in the accompanying figures the actual facts of the sunrise on the N.E. horizon at the longest day of the year in two British latitudes, Stenness, lat. 59° N., and Cornwall, lat. 50°. They will illustrate the effect of latitude upon azimuth as well as the change of azimuth in presence of hills which now specially concerns us.

[1] Continued from p. 544.

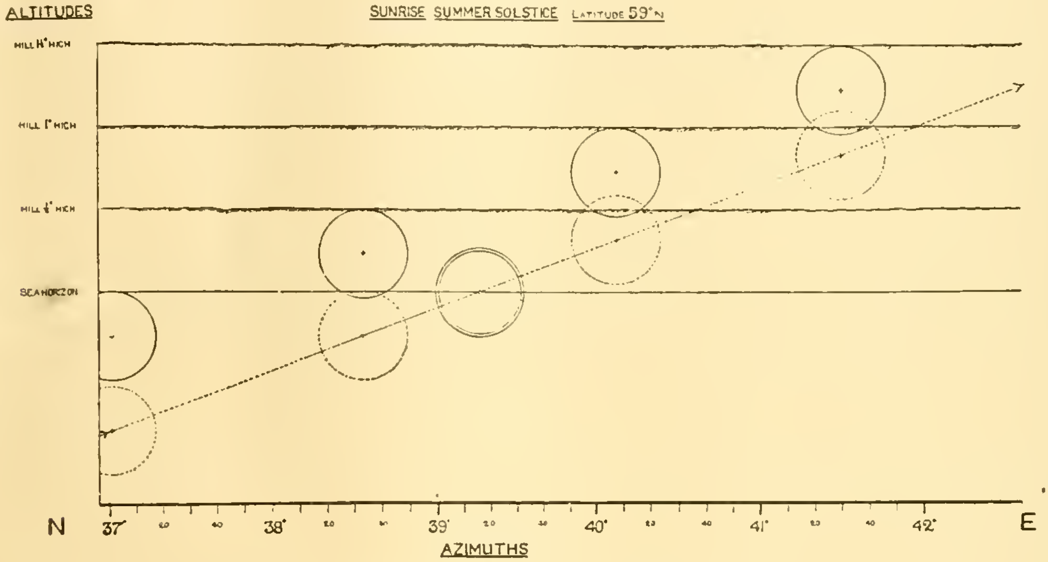


FIG. 19.—The conditions of "sunrise" at the summer solstice in lat. 59° N.

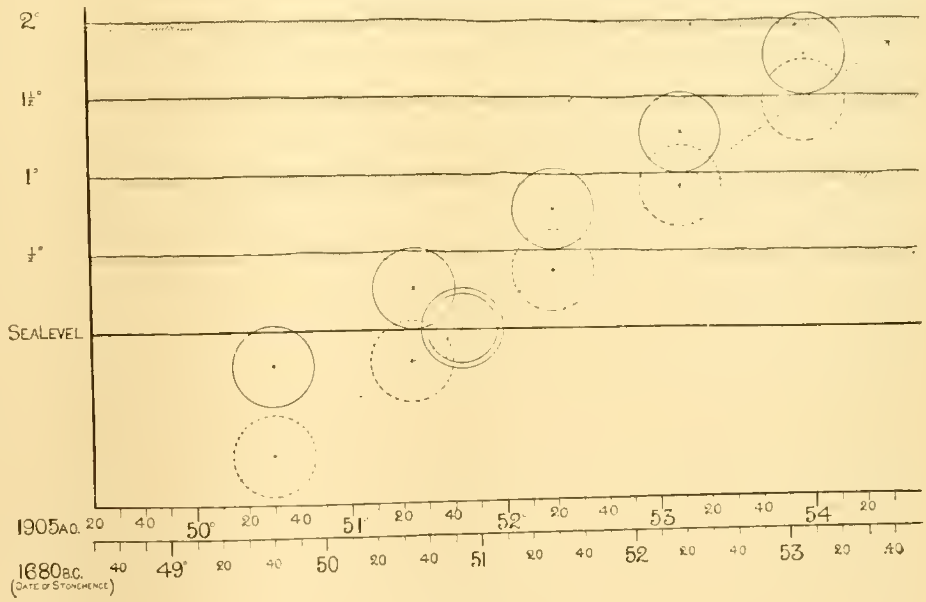


FIG. 20.—Showing azimuths in lat. N. 50° for the summer solstice sunrise, with different heights of hills for 1905 A.D. and 1680 B.C. (From "Stonehenge," p. 290.)

But before we consider them, I must refer to another matter.

The light from sun or star when it enters the earth's atmosphere is refracted or bent out of its course, and the more slantingly it enters the atmosphere, as happens near rising and setting, the greater the refraction. In consequence of this the sun or a star appears higher in the heavens than it really is, and therefore appears to rise earlier and set later.

In Fig. 19 we see, diagrammatically, the effect of hills and refraction on the azimuth of the summer solstice sunrise in lat. 59° N. The long dotted line shows the slanting direction of the sun's path in relation to the horizon. The double circle indicates the position of the sun's *centre*, at the sea horizon and neglecting refraction. The azimuth, as shown by the scale at the bottom of the diagram, is N. 39° 16′ E.

The full circles show the *apparent* positions of the sun due to refraction, at different horizons, if we apply the refraction correction and consider the sun visible

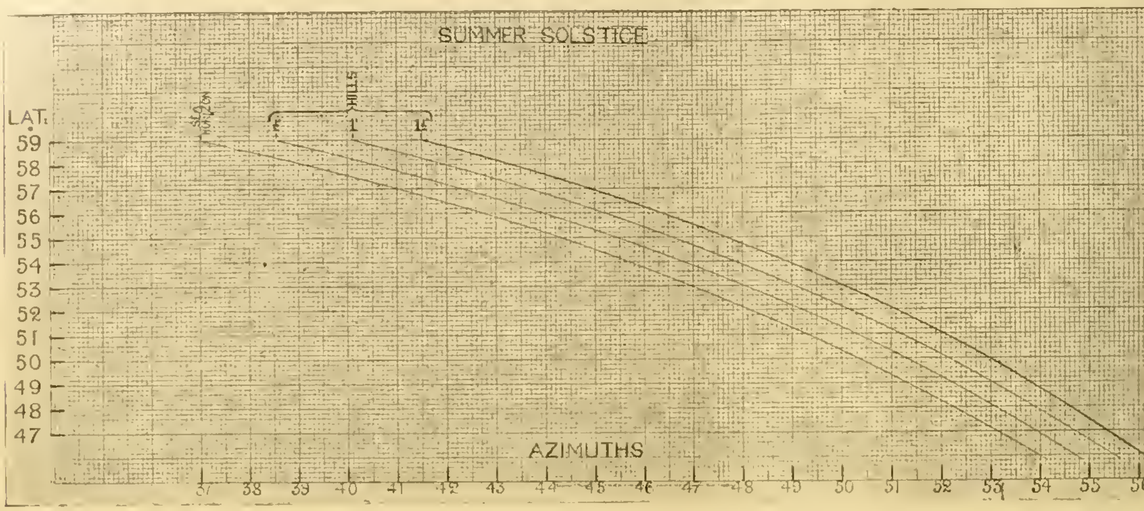


FIG. 21.—The Azimuths of the Sunrise (upper limb) at the Summer Solstice. The values given in the table have been plotted, and the effect of the height of hills on the azimuth is shown. The range of latitude given enables the diagram to be used in connection with the solstitial alignments at Carnac, Le Ménac, and other monuments in Brittany.

with 2′ of its diameter showing, whilst the dotted circles show the *real* position of the sun at the same moment. Thus, considering the lowest full circle,

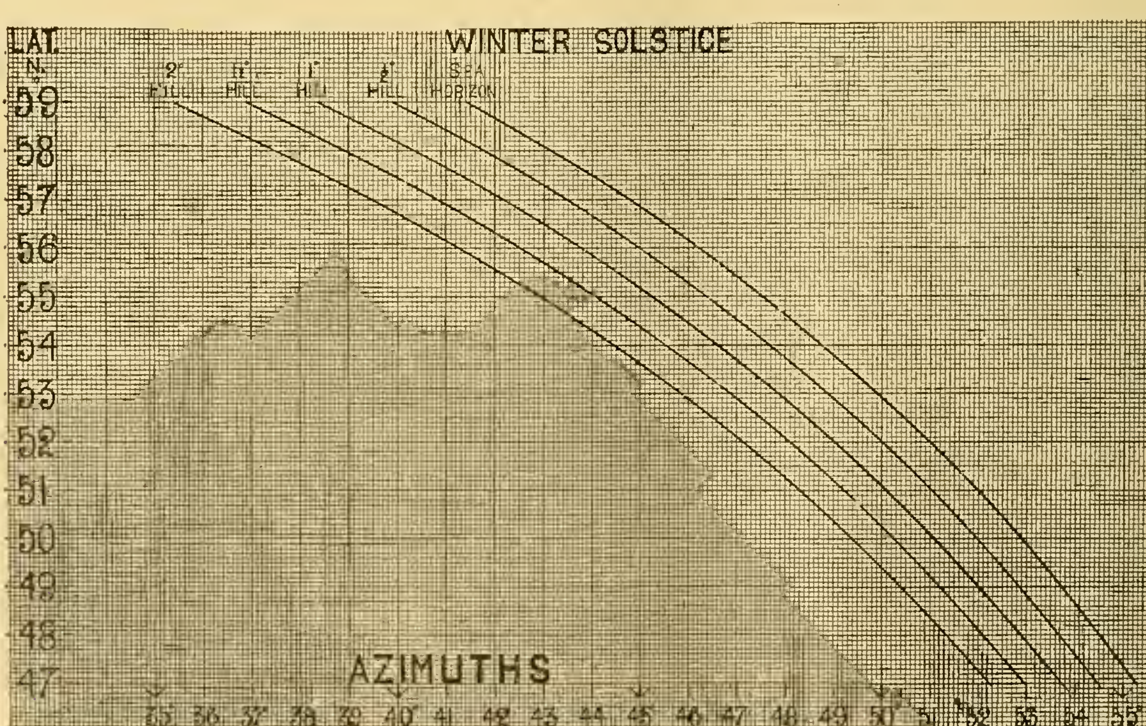


FIG. 22.—Azimuth of Sunrise (upper limb) at Winter Solstice.

in Fig. 19 we see that the azimuth of apparent sunrise, with a sea-horizon, is N. 37° 1′ E.

A comparison of the full-line circles with the lower dotted circles in the diagram will give an idea of the degree of apparent change of place brought about in this way; and how the difference between the true and apparent places rapidly diminishes as the true horizon is left behind. Thus at the sea horizon the true and apparent suns are just separated; with the horizon 1° high they interlock.

The next diagram gives the conditions for lat. 50°. In this latitude, while the sun appears to rise at the present time over the true sea horizon at azimuth N. 50½° E., instead of N. 37° E., as at Stenness, with a hill 2° high the azimuth is very nearly N. 54° E.

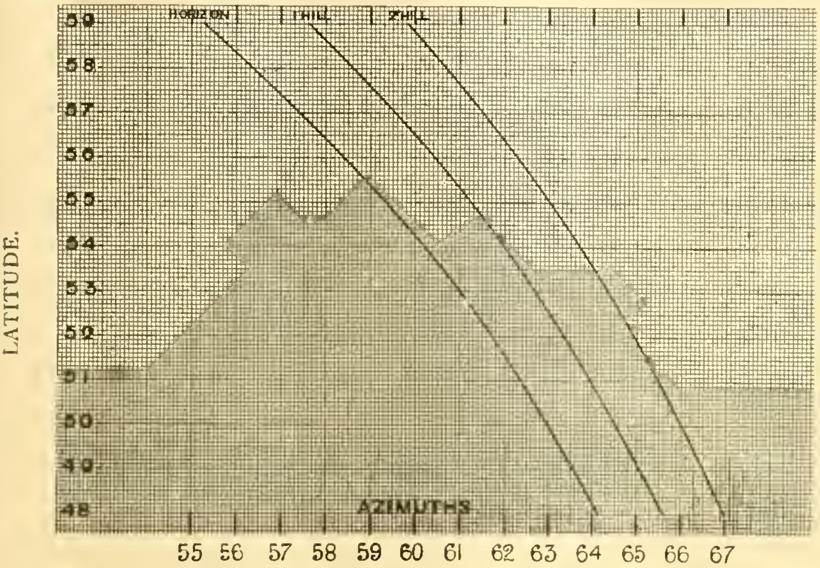


FIG. 23.—Azimuths of the May Sunrise. Sun s declination 16° 20′ N.

The above diagrams show very plainly the great variation in azimuth the archæologist has to reckon with when he roams Britain to determine the orientation of his monuments, whether outstanding stone, recumbent stone, avenue or cromlech. What happens with the solstitial sun also happens with the May and November suns, and warning- and clock - stars. Thus we find, in the case of the summer solstice sunrise, it is seen, with a sea horizon, in az. N. 37° E. at Stenness and N. 50° 30′ E. in Cornwall. A hill $1\frac{1}{2}°$ high in lat. 59° changes 37° to $41\frac{1}{2}°$; a hill 2° high in lat. 50° changes $50\frac{1}{2}°$ into 54°.

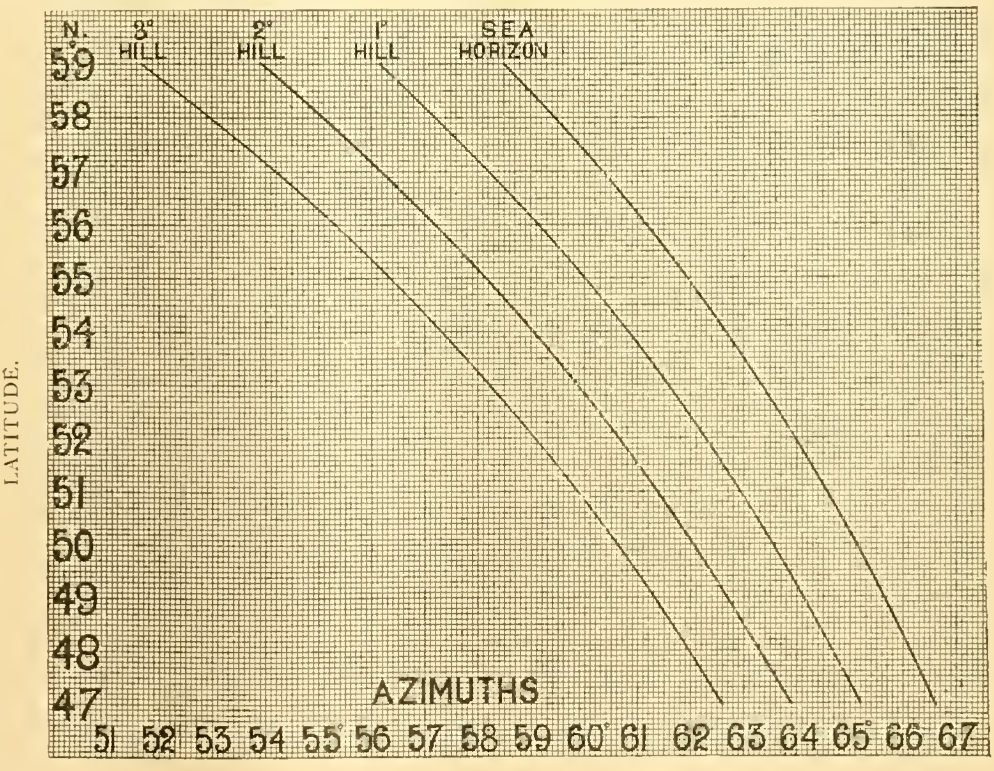


FIG. 24.- Azimuths of the November Sunrise Sun's declination 16° 20′ S.

Having now indicated the importance of the measurement of altitude as well as of azimuth, I give diagrams showing the azimuths of the sunrises at the solstices and in May and November, the changes in azimuth caused by varying heights of the horizon being also indicated.

These diagrams are good for the whole of Britain and for part of Brittany. They have been computed by Mr. Rolston, of the Solar Physics Observatory.

There is a relation between the height of the horizon and the refraction correction which may be found useful. If the horizon is half a degree high, the refraction is practically compensated, as the following table will show:—

| Elevation of actual horizon | Bessel's refraction | Combined effect |
|---|---|---|
| ° ′ ″ | ″ | ′ ″ |
| 0 0 0 | 34 54 | −34 54 |
| 0 10 | 32 49 | −22 49 |
| 20 | 30 52 | −10 52 |
| 30 | 29 3·5 | + 0 56·5 |
| 40 | 27 22·7 | +12 37·3 |
| 50 | 25 49·8 | +24 10·2 |
| 1 0 | 24 24·6 | +35 35·4 |

In the absence of measurements, it is convenient, therefore, to assume, in the first instance, that the height of the horizon is half a degree; then no refraction correction need be applied.

This relation is utilised in the preparation of general tables and curves, as it provides us with a convenient approximation to the actual azimuths before the height of the horizon has been measured.

Now, while the summer solstice sun thus rises in different azimuths with different heights of the horizon, its position in the heavens, that is, its declination, is unchanged. It is clear, then, that we cannot, by our azimuth measures alone, obtain the true position of the sun in the heavens, that is, in the celestial sphere. The same remark also applies to every star which rises and sets in the latitude of Britain. In addition to the azimuth of the rising or setting place, *we must also take the height of the horizon into account.* When we do this, the determination of the true position in the heavens, whether of sun or star—the declination—is easy.

As I shall show in the sequel, we have now the means, as the result of astronomical calculations, of determining the dates at which the sun or a star occupied declinations in times past different from those they occupy at present. All the archæologist has to do is to consult certain tables in which the sun's declination at the solstice and the varying declinations of the stars are shown for the past six thousand years. This is enough for the purpose the archæologist has in view.

NORMAN LOCKYER.

## THE GROWTH AND SHRINKING OF GLACIERS.[1]

THE interesting publications referred to below show that the study of the fluctuations of glaciers is making good progress. Those of the Swiss Alps have been watched systematically for nearly thirty years, and similar work is now being carried on, not only in all parts of that chain, but also in the Pyrenees, Scandinavia, Bokhara, the Altai, the Tian Shan, and the North American chains, and has been started in the Himalayas. In the European Alps a general retreat of the glaciers began about 1861. At first rapid, it slackened after a time, but, though here and there a glacier has slightly retraced its steps and an advance became more general towards the end of the last century, the majority are still either slowly shrinking or at best stationary. In the French Alps, we learn, sundry small glaciers have quite melted away during the last few years. It is to be hoped that these places will be carefully watched in order to ascertain more precisely the conditions (temperature, precipitation, &c.) under which the formation of a glacier becomes possible. That, as I pointed out in 1894 (see "Ice Work," part iii., ch. i.), would enable us to estimate the mean temperature in certain localities during the Glacial epoch, and thus to obtain one firmer footing in that most slippery subject. This shrinkage of the world's ice mantle, we may add, appears to characterise all the countries observed, for only in Scandinavia, and perhaps at Mount St. Elias, are glaciers beginning to advance in notable numbers.

Prof. Forel contributes to the special report on the Swiss glaciers a valuable discussion on the relations of their changes to the meteorology of the region, founded on observations which have been taken continuously at Geneva for the last eighty years. The advance or retreat of an ice-stream depends mainly on two factors: the annual snowfall and the general temperature, the one chiefly affecting its upper part, the other its lower. The effects, especially of the former, obviously cannot be immediate, and a glacier may continue its advance when the conditions are adverse, or *vice versâ.* As forty-three years elapsed before the relics of members of Dr. Hamel's party, who perished in a crevasse on the Ancien Passage, were discovered on the Glacier des Bossons, after travelling about five and a half miles, we must expect changes and their results to be separated by an interval, depending on the length, slope, and other characters of an ice-stream. It is perhaps too soon to generalise from Prof. Forel's discussion of the Geneva observations, and the distance of that observatory from the higher parts of the chain will always be a drawback; but the results are already suggestive, and his method of smoothing off the irregularities of individual years, by taking the mean of the decade which they close, enables us to form a better estimate of the real climatal changes. Time will render the work of the professor, his coadjutors, and all members of the International Commission increasingly valuable; for this is one of the cases where one generation must plant the tree and another gather the fruit.

T. G. BONNEY.

[1] "Les Variations périodiques des Glaciers." xii[me] Rapport, 1906, de la Commission internationale des Glaciers. Résumé par F. A. Forel. *Arch. des Sci. Phys. et Nat. Quatr. Pér.*, t. xxv., pp. 577–587.

"Les Variations périodiques des Glaciers des Alpes Suisses." By F. A. Forel, E. Muret, P. L. Mercanton and E. Argand. 28[me] Rapport, 1907. Extrait de l'Annuaire du S.A.C., xliii[me] année. Pp. 302–331.

## INTERNATIONAL CONFERENCE ON ELECTRICAL UNITS AND STANDARDS.

BY invitation of the British Government an International Conference on Electrical Units and Standards will be held in London at the rooms of the Royal Society during this month. Eighteen countries are sending delegates to the conference; the names are given below.

The first meeting of the conference will be held on Monday, October 12, at 11.30, when the delegates will be received by the President of the Board of Trade; in the evening there will be a reception by the Royal Society. The meetings of the conference are expected to last until October 22, but this date is not fixed, as it will entirely depend on the progress made with the work at the conference.

The main object of the conference is to obtain international agreement on the three electrical units, the ohm, the ampere, and the volt, so that the realisation of these units in all the countries of the world shall be as near as possible identical. The best method of setting up the mercury ohm, the silver voltameter, and cadmium cell will be considered, and it is hoped that detailed specifications may be issued with the authority of the conference.

The delegates will be entertained at an official banquet, and will lunch with the Lord Mayor; they will also make an excursion to Cambridge on the invitation of Trinity College, and pay a visit to the Cavendish Laboratory. The Board of Trade Government Standards Laboratory will be open to inspection by the delegates, and the National Physical Laboratory at Teddington will be visited. The delegates will also dine at the Franco-British Exhibition with the "Dynamicables," and are invited to the annual dinner of the Institution of Electrical Engineers.

### *List of Delegates.*

*America (United States).*—Dr. Henry S. Carhart, professor of physics at the University of Michigan; Dr. S. W. Stratton, director, Bureau of Standards, Washington; Dr. E. B. Rosa, physicist, Bureau of Standards, Washington.

*Belgium.*—M. Gérard, director of the Montefiore Electrotechnical Institution and president of the Consultative Commission on Electricity; M. Clément, secretary of the Consultative Commission on Electricity.

*Denmark and Sweden.*—Prof. S. A. Arrhenius, Nobel Institute, Stockholm.

*Ecuador.*—Senor Don Celso Nevares, Consul-General.

*France.*—M. Lippmann, member of the Institute and professor at the Sorbonne.

*Germany.*—Dr. Warburg, president of the Imperial Physico-technical Institute; Dr. Jaeger, member of the Imperial Physico-technical Institute; Dr. Lindeck, member of the Imperial Physico-technical Institute.

*Great Britain.*—The Right Hon. Lord Rayleigh, president of the Royal Society; Prof. J. J. Thomson, Cambridge; Sir John Gavey, C.B.; Dr. R. T. Glazebrook, director of the National Physical Laboratory; Major W. A. J. O'Meara, C.M.G., Engineer-in-Chief, General Post Office; Mr. A. P. Trotter, Electrical Adviser to the Board of Trade.

*Guatemala.*—Dr. Francisco de Arce, diplomatic representative, London and Paris.

*Italy.*—Prof. Antonio Roiti, of Florence.

*Japan.*—Mr. Osuke Asano, doctor of engineering, official expert of the Department of Communication, Tokyo; Mr. Shigeru Kondo, official expert of the Department of Communication, Tokyo.

*Mexico.*—Don Alfonso Castello; Don Jose Maria Perez.

*Netherlands.*—Dr. H. Haga, professor at the University of Groningen.

*Paraguay.*—M. Maximo Croskey.

*Spain.*—Don Jose Maria Madariaga, professor of electricity and physics at the School of Mines, Madrid.

*Switzerland.*—Dr. F. Weber, professor at the Swiss Polytechnic School at Zürich; Dr. Pierre Chappuis, of Bale; Dr. J. Laudry, professor of electricity in the School of Engineers, Lausanne.

*British Colonies: Australia.*—Mr. Cecil Darley; Prof. Threlfall.

*Canada.*—Mr. Ormond Higman, chief electrical engineer, Inland Revenue, Ottawa.

*Crown Colonies.*—Major P. Cardew, electrical adviser.

*India.*—Mr. M. G. Simpson, electrician of the Indian Telegraph Department.

## MR. BENNETT H. BROUGH.

ALL members of the Iron and Steel Institute, and, in fact, all those engaged either directly or indirectly in the manufacture of steel, were shocked by the sudden and unexpected death of Mr. Bennett Brough, the general secretary of the Iron and Steel Institute at Newcastle-on-Tyne, on Saturday last, after an operation for peritonitis. He had been attending the autumn meeting of the Institute in Middlesbrough, and up to Thursday appeared to be in normal health, and was taking his usual active part in making the meeting a success.

Mr. Brough was born in 1860, and was educated at the City of London School, and after graduating at the Royal School of Mines was for some time a student at the Mining School at Clausthal. Some time after the completion of his student career at Clausthal, he was appointed instructor in mine surveying at the Royal School of Mines, and only resigned on his appointment as secretary to the Iron and Steel Institute in 1893.

As early as 1885 he acted as a juror at the Inventions Exhibition, was a member of the Mining and Metallurgical Committees of the British Section of the Paris Exhibition of 1889, and of the St. Louis Exhibition of 1904, and the success of the Iron and Steel Section at the Franco-British Exhibition is in no small degree due to his great organising ability and untiring efforts.

Mr. Brough was not only a sound technical man, but a brilliant linguist, and a man of very wide culture and extensive travel. His well-known book on mine surveying and numerous contributions to the various technical and learned societies are known all over the world, and he was an accepted authority on mining matters.

He acted as examiner in mining at the Royal School of Mines, the Glasgow University, and the University of Wales, and he was a member of the council of the Institution of Mining Engineers; he served on the council of the Institute of Chemistry and the Chemical Society, and was also a Knight of the Swedish Order of Wasa.

As general secretary of the Iron and Steel Institute there were few men more widely known in the metallurgical world, and none more universally esteemed and respected. He was equally accessible to the youngest as to the oldest member of the institute, extending the same courtesy and consideration to all. He was a man of few words, but many kindly deeds, and not only those who were privileged to number him amongst their friends, but all who knew him, have suffered an irreparable loss.

## NOTES.

A SPELL of exceptionally brilliant and hot weather for so late in the year occurred over the whole of the British Islands during the last three days of September and the first four days of October, and in nearly all parts of the country previous records fail to show any shade temperatures as high for the corresponding period. At Greenwich the maximum readings exceeded 70° each day, and on the six days from September 29 to October 4 it was 75° or above, the absolutely highest temperature being 79°·9, on September 30. An examination of the Greenwich records from 1841 shows a temperature of 79°·2, on October 4, 1886, but there is no other reading higher than 78° so late in the season. At Nottingham 78° occurred on October 3, whilst the previous highest temperature during the month in the last thirty-five years is 75°, in 1895. At Bath 77° was registered on October 1 and 2, and the highest previous record for the month is 73°, in 1873. At Shields the reading was 77° on October 3, and the previous highest reading in October is 69°, in 1898. All previous records were also broken by 77° at Aberdeen, 76° at Jersey, Nairn, and Valencia, 75° at Holyhead, and 73° at Leith, between October 1 and 4. A feature of especial interest during the hot spell was the exceptionally warm nights, the thermometer commonly not falling below 60°. The Weekly Weather Summary for the period ending October 3, issued by the Meteorological Office, shows that the mean temperature was more than 11° in excess of the average in the north-east and north-west of England and in the Midland counties, whilst the sheltered thermometer registered 80° in all these districts. Much fog or mist occurred at night, and the air throughout the hot spell was exceedingly humid, the ground remaining damp all day where screened from the sun's rays. The primary cause of the hot weather was a quiet drift of southerly air from off the heated land in Spain and France, due to the prevalence of a region of high barometer readings over Germany. At Rochefort and Biarritz the sheltered thermometer registered 86° on October 2.

WE learn from the observatory department of the National Physical Laboratory that highly disturbed magnetic conditions prevailed there on September 29–30. A magnetic storm commenced suddenly about 1.32 a.m. on September 29. After 7.30 a.m. the curves were only slightly disturbed during a period of fully six hours, when fresh disturbance appeared. Considering the length of the interval, it was probably a case of two distinct magnetic storms. On this view, the first storm lasted about six hours, during which time the declination showed a range of 54′, while the ranges of horizontal force and vertical force were respectively about 225 $\gamma$ and 160 $\gamma$ (1 $\gamma$ = 0·00001 C.G.S.). The second storm, commencing suddenly about 1.45 p.m. on September 29, continued until 7 a.m. or

8 a.m. on September 30. During it the declination range was about 73′, while the ranges in horizontal and vertical force were each approximately 330 $\gamma$. On September 29 there was a remarkably fine oscillation in declination commencing at 6 p.m. In the course of eleven minutes the magnet swung 39′ to the west, with a return movement of 46′ to the east. In the course of this day, both in the morning and afternoon, there were a number of smaller but very rapid oscillations of the type usually associated with aurora. It is thus of interest to note that the Daily Weather Report of September 30 announces aurora as having been observed in various parts of Britain on the previous day, whilst the newspapers report the occurrence of unusually vivid aurora in the United States. It will be remembered that a large magnetic storm was recorded at Kew on September 11–12; it is unusual for disturbances so large as those of September 12 and 30 to occur in such rapid succession.

The Harveian oration of the Royal College of Physicians of London will be delivered by Dr. J. A. Ormerod on Monday, October 19, at 4 p.m.

The Italian Society of Sciences (Accademia dei XL) has awarded its biennial mathematical prize to M. Giuseppe Picciati, of the University of Padua, for his series of mathematical works.

Prof. E. C. Pickering, of Harvard University, has been elected president for the ensuing year of the Astronomical and Astrophysical Society of America, and Prof. W. J. Hussey, of the University of Michigan, the secretary of the society.

On October 6, at Le Mans, Mr. Wilbur Wright accomplished a flight of 1h. 4m. 26s. in duration, carrying a passenger. The nearest approach to this flight with a passenger was Mr. Wright's record of thirty-five miles in 55m. 35·6s. on October 3.

A conference of members of the Museums' Association and others interested will be held at Rochdale on Thursday, November 5, for the purpose of discussing subjects of interest to those concerned in the work of museums, art galleries, and kindred institutions.

The death of M. Alphonse Boistel, at the age of seventy-one years, is announced. M. Boistel was known as the author of a "Nouvelle Flore des Lichens," and as treasurer, and subsequently president, of the Geological Society of France. Science was a leisure-hour pursuit with M. Boistel, who for forty years was professor of commercial law in the University of Paris.

At the meeting of the German Meteorological Society in Hamburg, to celebrate its twenty-fifth anniversary, the following were elected honorary members:—Dr. W. N. Shaw, F.R.S., director of the Meteorological Office, London; M. A. Angot, director of the Bureau Central Météorologique, Paris; M. L. Teisserenc de Bort, director of the Observatoire de Météorologie dynamique, Trappes (France); and Prof. A. L. Rotch, director of Blue Hill Meteorological Observatory, U.S.A.

On Saturday, October 10, the Essex Field Club will hold a conference and demonstration at the Franco-British Exhibition. The main object of the meeting will be to demonstrate the value of some of the exhibits as illustrations of the methods which may be employed in promoting and encouraging nature-study in schools, and to discuss the best mode of utilising local museums as centres and standards of reference in such instruction. All interested in these subjects are invited to attend. Applications for programmes and other information should be made to the hon. secretary, Mr. W. Cole, Buckhurst Hill, Essex.

The death is announced, in his sixty-ninth year, of Dr. Francis Huntington Snow, who took a prominent part in scientific teaching in the University of Kansas from its establishment in 1866. He was Chancellor of that University from 1890 to 1901, and after his retirement from that post continued to hold the chair of systematic entomology. In recognition of his services the Kansas Legislature built several years ago the Snow Hall, to hold his valuable collection of 22,000 insects, made during twenty-six expeditions in Kansas, Colorado, New Mexico, Texas, and Arizona. American farmers owe much to his experiments in the artificial application of fungus diseases to the destruction of chinch bugs, especially in the wheat fields.

The latest development of the policy of the Forest Service at Washington is the projected establishment in the west of a number of forest experiment stations, which, it is anticipated, will do for American forestry what the agricultural experiment stations have done for the country's farms. The first station of the series has been established in the Coconino national forest, with headquarters at Flagstaff, Arizona. Here special attention will be paid to a study of the reproduction of the western yellow pine and the causes of its success and failure. One of the most important functions of these stations will be the maintenance of model forests, typical of the region, as object-lessons for professional foresters, lumbermen, &c.

Writing to the *Times* of October 1, Mr. R. Burnard, hon. secretary, Dartmoor Preservation Association, states that the most serious destruction of antiquities, and one for which, apparently, there can be no excuse, has just been reported to him. It appears that the War Office recently acquired a large tract of country at Willsworthy, near Lydford, for training purposes, and on this stands White Hill, an eminence of nearly 1300 feet, recently crowned by thirteen tumuli; these have been swept away, in order, so it appears, that a flagstaff may be set up. Mr. Burnard adds:—"The ignorance of a country road-mender helping himself to what is handiest in the way of stone may be excused, but this last destruction is at present inexplicable, for assurances were given when the property was acquired that all the antiquities would be respected as far as the exigencies of the service would permit."

A brilliant assembly, organised by the committee for the erection of a monument to the late Prof. Marcelin Berthelot, the founder of synthetic chemistry and of thermochemistry, met at the Sorbonne on Sunday night. M. Fallières, President of the French Republic, was present, and also M. Clemenceau, the Prime Minister, and M. Doumergue, Minister of Education. We learn from the Times that in an eulogy upon the great *savant* M. Raymond Poincaré said:—"After his death there was found on his table, indicative of his last thoughts, a memoir on the alkaline compounds in vegetables, an old Arab manuscript on alchemy, which he had only just managed to obtain from the Mosque of Fez, and an address to the French of the Argentine Republic. He had thus, for the last time, united in his final preoccupations truth and the fatherland." M. Fallières also spoke eloquently of Berthelot, who, he remarked, remained to the last one of the noblest apostles of science, of independent thought, of justice, and of truth.

Dr. and Mrs. Bullock Workman, accompanied by Dr. C. Calciati and Dr. M. Koncza, surveyors, have carried out successfully a detailed survey of the Hispar glacier in Hunza-Nagar. We learn from the *Pioneer Mail* that, after remaining five weeks on the Hispar, camping much of the time on snow, at altitudes of from 16,000 feet to 19,500 feet, Dr. and Mrs. Bullock Workman, with guides and a caravan of Nagar coolies, crossed the Hispar pass and descended the Biafo glacier—thirty miles long—reaching Askole, Baltistan, on August 26. Although the chief objects of the expedition were glacial study and mapping, several new peaks and snow passes were climbed, the most notable being a very steep and difficult snow peak of about 22,000 feet, situated some distance to the north of the Hispar pass, on the watershed of the Hispar and Biafo glaciers, overlooking the solitudes of Snow Lake at the head of the Biafo glacier. This is the second traverse by Europeans of these two glaciers, the first having been made by Sir Martin Conway in 1892.

Mr. J. T. Cart, whose death we announce with regret, entered the School of the Pharmaceutical Society in October, 1902, as Bell scholar, was appointed demonstrator in chemistry in October, 1903, and demonstrator in pharmaceutics in April, 1904, a post which he held until he took up an appointment with the firm of Messrs. Hopkin and Williams in July, 1905. There he gained additional experience in analytical and manufacturing chemistry under the supervision of Mr. Edmund White, leaving in 1906 for Newcastle-on-Tyne, where he was appointed chemist to Messrs. C. A. Parsons and Co. to carry on chemical engineering research work, and to deal with such chemical questions as arise in the carrying on of engineering and electrical business generally. His work while at Newcastle threw him much into contact with Mr. Charles A. Parsons and others, who held him in the highest regard. To all who had the privilege of his acquaintance and friendship, his sudden and untimely death has come as a great shock and sorrow. Mr. Cart was a B.Sc. of London University, an Associate of the Institute of Chemistry, and a member of the Northern Scientific Club.

Vol. xiii. (pp. 547–752) of the Transactions of the South African Philosophical Society is devoted to the concluding portion of the descriptive catalogue of the Coleoptera of South Africa, and deals mainly with the family Scarabæidæ, of which a large number of new species is described. It is illustrated with one plate.

About thirty years ago a remarkable collection of fossil plants and insects was discovered in beds of shale of the Miocene period at and near Florissant, a small town in Colorado. The plants were described by Lesquereux, and Dr. Scudder published an important monograph on Tertiary insects. Interest in these remains has again been aroused by recent workings, upon which subject Prof. T. D. A. Cockerell contributes an article to the *Popular Science Monthly* (August). The flora included many trees similar to those existing in other parts at the present day, such as Liquidambar, redwoods, and cottonwoods, also an abundance of ferns. Two unique specimens were discovered in the shape of a fungus that has been named *Didymosphaeria betheli*, and a tuft of moss bearing capsules. Some remarkable insects were also unearthed, notably a Glossina, or tsetse-fly, a genus now confined to Africa, also a genus, Halter, known only at the present day in Chile, and two butterflies.

In their report for 1907–8, the authorities of the Manchester Museum announce the acquisition of a tomb-group of the twelfth dynasty, discovered by Prof. Flinders Petrie at Rifeh, Upper Egypt, and consisting of two painted sarcophagi, with body-coffins and mummies, two boats with sailors, a finely painted canopic chest, of which all the contents are complete, and five statuettes, all being of the best workmanship. Reproductions from photographs of the statuettes and boats accompany the report, which also contains an illustration of a family group of striped hyænas recently added to the exhibition-series.

The School Nature Study Union has issued a series of leaflets intended for teachers or for use in class. The early numbers are introductory, indicating the facilities offered by museums and gardens—we should have expected the reverse order—in and near London, suggesting schemes for study, and giving a list of useful books. Subsequent publications deal with seeds, bulbs, sun-dials, tree twigs, rocks, insects, and the school aquarium. The note on sun-dials and how to make one, by Miss N. Sweeny, is certain to be useful, and Miss S. E. Isaacson has collated the chief characters of the more prominent insects. Miss K. M. Hall has provided a practical article on the culture of bulbs. The leaflets can be obtained from the secretary of the union, 1 Grosvenor Park, Camberwell.

The first part of the eighth volume of the *Museums Journal* contains the annual report of the Museums Association. This is in every way satisfactory, the membership showing some increase, while the sale of the journal has also expanded. The presidential address, by Dr. Jonathan Hutchinson, was devoted to the *rôle* of museums from an educational point of view. In this respect simplicity was strongly insisted upon as one of the most necessary factors, while the president likewise dwelt upon the importance of a "space-for-time-method" for exhibition purposes. In the museum at Haslemere, for example, the building devoted to geology is divided into a number of equal-sized compartments, each supposed to represent a period of one million years, and severally devoted to different geological epochs. The idea certainly seems worthy of further development.

In a recent number of the *Comptes rendus de la Société de Biologie* (vol. lxiv., p. 1004), Messrs. Chatton and Alilaire describe a new species of trypanosome, very similar in appearance to *Trypanosoma dimorphon*, found by them in the Malpighian tubules of *Drosophila confusa*, Stæger, a small fly common in distilleries and breweries feeding on yeasts. In the intestine of the Drosophila the authors also found a Herpetomonas, which they think may represent a stage of the trypanosome. This is the first time that a true trypanosome has been found anywhere but in the blood of a vertebrate or the digestive tract of a blood-sucking invertebrate, though species of the allied genus, Trypanoplasma, are known to occur in the gut as well as in the blood of fishes. It is greatly to be hoped that the authors will follow up their discovery by working out the life-cycle of the trypanosome and its mode of transmission from one host to another.

The report of the Alexander McGregor Memorial Museum, Kimberley, for the period ended December 31 last has just been received, from which we note that substantial progress has been made in the fitting up and equipment of the institution; also that Miss Wilman, of the South African Museum, has been appointed curator, and that she will take up her duties by the end of February next. The board trusts, "as all other museums in the colony have received, at the least, pound for pound grants in aid of building and furnishing funds, in addition to annual grants for upkeep, that the Government will, as soon as its funds permit, make a substantial grant in aid of the fitting-up of this museum, as well as an increased grant in aid of upkeep, so as to enable the only museum in northern Cape Colony to be organised and administered in a manner worthy its place as an educational institution."

THE dread of premature burial has always been a very real one among some members of the community, so much so that an association for the prevention of premature burial exists. Its physician-in-chief, Mr. Brindley James, has issued a booklet entitled "Death and its Verification" (Messrs. Rebman, Ltd., price 1s. net), in which the various tests of death are detailed. They are all simple ones, and some will probably be new to most practitioners.

THE study of the topography and municipal history of Praeneste, contributed to series xxvi. of the Johns Hopkins University papers on historical and political science by Mr. R. Magoffin, opens a collection of geographic-historical memoirs on the cities of the Latin League which promises to be of considerable interest. The position of the city, the modern Palestrina, situated on Mount Glicestro, marks it out as the strategical key of Rome, and its political and religious rival. The study of the remains of the cyclopean walls, with their gates open in the direction of the chief water supply, the reservoirs, the remarkable pair of caves, whence, as tradition tells, when the rock was opened pieces of wood inscribed with ancient characters leaped out, afterwards associated with the curious cult of Fortune Primigenia, and the details of the municipal government, based upon a study of the epigraphical materials, is a good example of the new methods of investigation which are now being applied to the solution of the archæological problems of the ancient Italian cities. Mr. Magoffin promises elsewhere to provide a coloured diagram showing the stages of the city's growth. His review of the many problems connected with the site would have been more readily intelligible if the present memoir had been accompanied by a sketch-map.

THE Commonwealth Bureau of Meteorology, Melbourne, under the superintendence of Mr. H. A. Hunt, has commenced the publication of bulletins dealing with the meteorology of the whole of Australia. No. 1 (issued March) is an excellent general epitome of the climate and meteorology of that continent, by Mr. G. H. Knibbs, reprinted from the year-book of the Commonwealth, and contains the averages and extreme values at the Australian capitals from a long series of observations, illustrated by diagrams showing the annual fluctuation of the various elements. No. 2 (issued July) deals specially with rainfall, and includes a map showing the mean annual values for the decade ending 1906 (an unusually dry period). The map shows that the heaviest rains fall over the northern and eastern parts of Australia; Mr. Hunt states that the most trustworthy, although lighter rains, are experienced over the south-western and south-eastern portions, including Tasmania. These bulletins may be welcomed as an important addition to meteorological literature.

THE annual report of the Royal Alfred Observatory, Mauritius, for 1907 shows that the rainfall for that year, from a mean of sixty-seven stations, was 13 inches below the average. The tracks of four out of eight cyclones which occurred in the Indian Ocean have been plotted. Photographs of the sun were taken daily when the weather permitted, and 300 negatives were sent to the Solar Physics Committee; particulars of fifty-four earthquakes were forwarded to the Seismological Committee of the British Association, and weekly summaries of the weather from May to December were cabled to the director-general of Indian observatories in connection with the monsoon predictions. We regret to learn that the clerical work is falling into arrear, owing to a reduction in the vote for extra assistance, and that from want of funds the observations for 1902 and 1903 are still unprinted. The value of the work of the observatory in connection with international cooperation can hardly be overrated; it is one of the places mentioned in the resolutions of the International Association of Academies at the meeting in May, 1907, and the Meteorological Committee (London), referring to this subject in its last annual report, mentions the observatory as "one of the most important scientific establishments of the southern hemisphere."

WE have received from Messrs. Heynes, Matthew and Co., of Cape Town, a catalogue of scientific apparatus stocked by them. The list includes apparatus for collecting and storing botanical, zoological, and mineralogical specimens, also microscopes, reagents, and instruments required in bacteriology. We notice among the contents wire presses for drying plants, Grubler's stains, Hearson's incubators, and geological outfits for prospectors. It will interest readers in South Africa to know that these can be obtained without sending to Europe.

IN a note in the Transactions of the American Mathematical Society, ix., 2, Prof. J. L. Coolidge discusses the "equilong" transformations of space. In an "equilong" transformation, if any oriented plane is cut by three non-coaxial oriented planes infinitely near thereto in a triangle, this triangle transforms into a triangle equal in all respects to it. The author finds that the most general "equilong" transformation in a Euclidean space of $n$ dimensions depends on the most general conformal transformation of a space of $n-1$ dimensions, and an arbitrary function of the direction parameters. The distance parameter enters linearly. The mathematical proof which is given for three-dimensional space is easy to follow.

AN important essay on logic and the continuum has been contributed to the Bulletin of the American Mathematical Society for June by Prof. E. B. Wilson, of Boston, U.S.A. It deals largely with Zermelo's proposed solution of the problem, first stated by Prof. Georg Cantor in 1883, as to whether every set, and in particular the continuum, can be well ordered. In a postscript the author refers to Schœnflies's report on the same subject. Among Prof. Wilson's conclusions, the view is put forward that the well ordering of any set is of practically no significance, and is quite worthless apart from an algorithm which accomplishes the ordering—an algorithm which shall not require an operation which transcends the cardinal number of the given set. This quotation must be regarded as a mere indication of the general character of the questions discussed in the paper.

THE fact that the salient feature of modern practice is the successful handling of low-grade materials from which the value could not profitably be extracted by older methods is strikingly emphasised in an article on modern developments in the metallurgy of lead and zinc, by Mr. A. Selwyn-Brown, in the *Engineering Magazine* (vol. xxxv., No. 6). Descriptions are given of the Huntington and Heberlein process, the Carmichael-Bradford process, the

Savelsberg process, pot roasting, briquetting fine sulphides, the Dwight and Lloyd sintering process, flotation processes, and the Macquisten process. While these metallurgical inventions deal with base metals, it must not be forgotten that the ores treated almost always contain appreciable quantities of gold and silver, which they will concentrate and save.

A neat method of showing the hydrolysis of salts as a chemical lecture experiment is described by Mr. B. L. Vanzetti in the *Gazzetta* (vol. xxxviii., ii., p. 98). An ordinary test-tube is three parts filled with a solution of gelatin coloured with litmus or with phenolphthalein rendered pink by a trace of alkali. A solution of an easily hydrolysed salt, such as ferric chloride, is poured on to the surface of the gelatin after the latter has set. In a short time two zones become visible in the gelatin, one of which, the lower, travelling more quickly through the gelatin, is due to acid, which renders the phenolphthalein colourless; the second zone, at the surface of the gelatin, is coloured by the hydroxide of the base. In the case of ferric chloride this zone is dark brown and opaque, owing to ferric hydroxide being formed. Coloured salts, such as copper sulphate on cobalt nitrate, can also be conveniently used.

From the Cambridge University Press Warehouse, Fetter Lane, we have received copies of three forms designed to facilitate the astronomical computations of time, azimuth, and latitude. These forms have been arranged by Messrs. A. R. Hinks and H. K. Shaw, of Trinity College, for use in the Cambridge Geography School, and are somewhat similar to, but more elaborate than, those used for some years past by the students at the Royal College of Science, South Kensington. The first form is for computing time or azimuth from observations of the sun's altitude, and the second for the analogous computation from the altitude of a star, whilst the third is set out for the computation of latitude from circum-meridian observations of sun or star. Such forms are invaluable, especially to those observers who, knowing the general methods, are yet a little hazy as to the details of the computations, for unless one is making and reducing the observations regularly it often occurs that the simplest method of computing is but imperfectly remembered; hence follows loss of time and unnecessary increase of labour; but on these forms every correction, every step in the computation is clearly set out, and it becomes impossible for the observer to forget a correction or to apply a wrong function. In addition to this, each form contains a few useful hints and a diagram to be filled in showing exactly the angles measured. Whilst the forms appear to be otherwise complete, we think it would enhance their value were the entire formula employed inserted, because this would often give the occasional observer a valuable reminder as to the exact form of computation he was employing. The forms are sold in strong envelopes, and the price of each envelope, containing twelve copies of one form, is one shilling net.

Mr. Thomas Thorp, of Guildford, has issued a catalogue of the books on botany and gardening, zoology, geology, mathematics and physics, offered by him for sale.

A subject list of works of reference, biography, bibliography, the auxiliary historical sciences, &c., in the library of the Patent Office has just been published at the Patent Office, 25 Southampton Buildings, W.C.

The second part of the second French edition of Mr. W. Rouse Ball's "Récréations mathématiques et Problèmes des Temps anciens et modernes" has just been published by M. A. Hermann, Paris. The translation follows the fourth English edition, and Mr. J. Fitz-Patrick has added to it some new subjects of interest, among them being parquetry or tiling, the game of dominoes, and constructions for the squaring of the circle.

## OUR ASTRONOMICAL COLUMN.

Comet Morehouse, 1908c.—Several observations of comet 1908c are recorded in No. 4274 of the *Astronomische Nachrichten* (p. 29, September 23). M. Chofardet, observing at Besançon on September 5, describes it as having a round, nebulous head, of ninth magnitude and 2'.5 diameter, without any definite nucleus. A short, indistinct tail was seen projecting from the head in a N.W. direction. On September 6, 7, and 8, Prof. Abetti, at Arcetri, found the comet to have an oblong nebulous appearance without nucleus, its diameter being 2' and its magnitude 9.0.

Herr Ebell continues the ephemeris published by Prof. Kobold in a previous number, and the following is an abstract therefrom:—

*Ephemeris 12h. M.T. Berlin.*

| 1908 | α (true) h. m. | δ (true) ° ' | log r | log Δ | Brightness |
|---|---|---|---|---|---|
| Oct. 8 | 19 57.9 | +61 21.4 | 0.2010 | 0.0154 | 4.8 |
| ,, 10 | 19 45.9 | +57 59.9 | 0.1942 | 0.0100 | 5.0 |
| ,, 12 | 19 36.1 | +54 30.3 | 0.1872 | 0.0062 | 5.3 |
| ,, 14 | 19 28.1 | +50 55.3 | 0.1801 | 0.0043 | 5.5 |
| ,, 16 | 19 21.4 | +47 17.7 | 0.1730 | 0.0041 | 5.7 |
| ,, 18 | 19 15.9 | +43 40.0 | 0.1657 | 0.0058 | 5.9 |
| ,, 20 | 19 11.3 | +40 4.2 | 0.1584 | 0.0090 | 6.0 |
| ,, 22 | 19 7.5 | +36 32.6 | 0.1510 | 0.0139 | 6.1 |
| ,, 24 | 19 4.3 | +33 6.7 | 0.1436 | 0.0201 | 6.0 |

The apparent positions of the comet among the stars, according to the above ephemeris, are shown approximately


Chart showing apparent path of Morehouse's Comet, October 8–24

on the accompanying chart; it will be noted that the comet passes quite close to the fourth-magnitude star ι Cygni on October 14. According to an observation made at Copenhagen on September 20, the corrections to be applied to the ephemeris position were +1m. 18s. and −1′.3. Prof. H. Thiele also states that the comet was visible to the naked eye, and that the tail was 1°.5 long with a bend, amounting to 13°, at 12′ from the head.

As pointed out in a letter received from Prof. Dale, the positions given by the Lick ephemeris gradually became worse until, on October 3, the error amounted to about 3°. Elements computed by Prof. Dale differ but little from those computed by Prof. Kobold, whilst an ephemeris with which he has favoured us gives the following positions for October 8 and 14 respectively:—R.A. 20h. 2·8m., dec. +61° 52′·4; R.A. 19h. 31·5m., dec. +51° 40′·8. For the Kiel ephemeris Prof. Dale's observations on October 3 indicated an error of −3·4m. and −18′, whilst later observations indicate that the departure from the ephemeris positions is steadily increasing.

COMET TEMPEL$_3$-SWIFT.—The comet Tempel$_3$-Swift, for which we gave a search-ephemeris in these columns last week, was re-discovered by M. Javelle at the Nice Observatory on September 29. The following was its position at 15h. 9·4m. (Nice M.T.) on that date:—

R.A. = 6h. 44m. 14·6s., dec. = +32° 37′ 55″.

Of the three ephemeris positions given for September 29, this agrees best with that calculated for the mean date (September 30·88) of the perihelion passage. When re-discovered, the magnitude of the comet was 14·0, and its distances from both earth and sun are increasing. Its present position is in the constellation Gemini, and it is apparently travelling, according to the ephemeris, towards Castor and Pollux.

BRIGHT BOLIDES.—A meteor, considerably brighter than Vega, was observed by Mr. W. Moss at Wimbledon Park, at 7h. 4m. p.m., on October 1. Its approximate path was from 213°, +76½°, to 183½°, +78½°, its colour bluish-white, and its velocity medium. At its disappearance the meteor exploded, leaving a short trail. Mrs. E. Gifford, writing from Oaklands, Chard, says that at about 5.45 p.m. on October 1, while looking at the moon, which was to the south-west of her, she saw a shooting star of a brilliant blue-green colour to the east of the moon. It was still broad daylight, and the meteor gave the impression of an oblong patch of light followed by the usual streak.

THE SIXTH SATELLITE OF JUPITER.—Position measures of Jupiter's sixth satellite, made with the Yerkes 40-inch refractor during the period March 24 to May 3, are recorded in No. 4274 of the *Astronomische Nachrichten* (p. 17) by Prof. Barnard; the estimated magnitudes of the satellite were as follows:—March 24, 14·5; April 13, 14·0; April 19, 14·2; April 21, 14·5; and May 3, 14·0.

A faint nebula of the sixteenth magnitude was seen in the same field as the satellite on March 24, its position, for 1908·0, being $\alpha$ = 8h. 26m. 56·58s., $\delta$ = +19° 55′ 55″·4.

THE SOLAR ROTATION AS DETERMINED FROM THE MOTION OF DARK CALCIUM FLOCCULI.—In a brief note, appearing in No. 2, vol. xxviii., of the *Astrophysical Journal* (September, p. 117), Mr. Philip Fox gives a few preliminary results obtained by him in the determination of the solar rotation from measurements of the dark calcium flocculi. The evidence so far educed shows that these features are of the same order of height in the solar atmosphere as the hydrogen features, which show a constant period of rotation for all heliographic latitudes. Grouping the latitudes from 20°–25°, 25°–30°, and 30°–35°, Mr. Fox obtains mean diurnal motions of 14°·32, 14°·10, and 14°·14 respectively, thus indicating that the motion is independent of latitude; that is to say, from the results already obtained by Profs. Hale and Adams, these dark calcium flocculi belong to the higher levels of the solar atmosphere. Mr. Fox also confirms the previous observations that the dark flocculi are prominences seen in projection on the disc, but finds that they are not so easily seen as the corresponding dark hydrogen flocculi.

## IRON AND STEEL INSTITUTE.

THE autumn meeting of the Iron and Steel Institute was held at Middlesbrough on September 28 to October 2 under the presidency of Sir Hugh Bell, and was largely attended. The institute was welcomed in an eloquent speech by the Mayor of Middlesbrough, and the president, after acknowledging the welcome, announced that Sir William T. Lewis, Bart., K.C.V.O., had been chosen to succeed him in the presidential chair in May, 1909. Sixteen papers were on the programme, and three mornings were devoted to their reading and discussion.

The first paper read was by Mr. J. E. Stead, F.R.S., who exhibited and described a simple form of inexpensive microscope suitable for the use of foundry foremen and of assistants in steel works.

The next paper read was that by Mr. W. Hawdon (Middlesbrough), on the iron and steel industries of the Cleveland district. He gave a brief review of the iron and steel industries of the Cleveland district during the last quarter-century, *i.e.* since 1883, on the occasion of the last visit of the institute to Middlesbrough, to the present time. The record showed that the iron and steel trade of the district had considerably increased and its position consolidated. The population of Middlesbrough had doubled, but the output of Cleveland ironstone remained about as it had been. In 1899 the first basic open-hearth steel was produced in the district, 10,154 tons being made in that year. The output has rapidly increased, and the question arises, if this increase of basic open-hearth steel continues, where is the ironstone to come from? The best ironstone is rapidly going; there is, however, a large area of stone, of a gradually diminishing richness, or rather of increasing poverty, available for many years to come. If, then, at the end of another quarter of a century the Iron and Steel Institute again visits the district, it may see, should the steel age still be vigorous, a greater output of basic steel and a larger production of pig-iron from native ironstone, which will be won, if not by manual labour, then by one of the many devices which are and will be available for the purpose.

Mr. T. C. Hutchinson (Saltburn) read a paper on the mechanical cleaning of iron ores, in which he considered the most economical method of treating any description of ore by careful selection, and the removal by mechanical means of as much of the impurities as can be easily distinguished by their appearance. He gave his experience in dealing with and smelting Cleveland ironstone when worked for a period of years from the same mine, and tabulated the yield of iron from the ore, and the consumption of fuel and flux required under various conditions due to the irregularity of impurities admixed with ore as delivered from the mines. Many years of careful observation have led him to the conclusion that, whether these impurities are charged into the furnace in larger or smaller percentages as compared with the main bed of ironstone, the coke and limestone requirements and the cost of smelting increase in exact ratio. It is cheaper to pick out impurities mechanically than to melt them out in the blast-furnace. Mechanical cleaning is desirable, and can be applied to all descriptions of ores used in the manufacture of pig iron.

The paper read by Mr. Greville Jones (Middlesbrough), on Messrs. Bell Brothers' blast furnaces, was of great historical interest and educational value. He gave full particulars and dimensioned drawings of the furnaces built by the firm from 1844 to 1908.

A paper by Prof. H. Bauerman (London), on metallurgy at the Franco-British Exhibition, was read by title only, as the author, being a member of the jury, considered that the paper should not be published until the official list of awards had been announced. In connection with this paper, a compilation of analyses of British pig-irons shown at the Exhibition was presented by Mr. Bennett H. Brough. In view of the paucity of published analyses, it forms a very useful work of reference, as the exhibits shown in the Collective Pig-Iron Stand have been carefully selected as typical for the various districts represented.

The paper read by Mr. C. H. Merz (London), on the effect of power supply on the industries of the north-east coast, proved conclusively that manufacturers in that district are quick to avail themselves of new developments or of additional facilities. The generating plant now amounts to 56,000 electric horse-power, and power supply, though of comparatively recent development, has already had a marked effect upon the industries of the north-east coast. A great saving of coal and reduction of smoke have resulted; there is now, apart from the Power Company, practically speaking, no coal burned on the Tyne for power purposes except in chemical factories. The Tyne shipyards and engineering works may be said to have adopted electricity to the exclusion of all other forms of motive power. The application of electricity to all new uses has been facilitated. New industries have been established in the district purely because of the cheap power supply available, and a substantial commencement has been made in the utilisation of the waste heat and gases existing in the area; and in this regard the district occupies a unique position owing to the extent to which its future power requirements can be met by electricity produced as a by-product of two of its largest industries, the making of pig-iron and the making of coke.

Mr. C. Koettgen (London) and Mr. C. A. Ablett (London) read a paper on electrically driven rolling-mills, in which they gave figures showing the power required for rolling different sections, the figures being taken from among the results obtained from 150 rolling-mills. Such results should prove of considerable assistance in settling the correct size of the motor for a new mill for a given output of similar sections.

A paper read by Mr. S. Cowper-Coles (London) was of special interest. Hitherto it has been the universal custom to produce iron sheets, tubes, and wire by a process of smelting the iron, refining, cementation, annealing, rolling, or drawing. The author, however, describes an electrolytic process for making tubes, sheets, and wire in one or two operations from crude or scrap iron, or direct from the ore, without the processes of smelting, rolling, or drawing, at a cost that has hitherto been thought impossible. The process can also be used for the production of seamless cylindrical vessels. The process presents numerous advantages. Finished products can be produced at less cost than by the processes of smelting, refining, and rolling; a product is obtained which does not corrode so readily as steel at less cost; the process can be worked economically when no coal is available, but water-power only; iron ore that is useless for ordinary smelting operations can be advantageously utilised by the electrical process; the process is a power process, and utilises but little labour; small units can be worked economically; the process is more cleanly and healthy than the ordinary operations; and little or no scrap is formed.

Mr. E. H. Saniter (Rotherham) submitted a paper on a test for ascertaining the relative wearing properties of rail steel. The principle of the testing machine devised is that there is a round test-piece revolving a fixed number of revolutions and rotating by friction the inner ring of a ball-bearing loaded with a fixed weight, the action being similar to that of a wheel rolling on a rail.

The paper communicated by Mr. A. E. Pratt deals with the possibility of extending the utility of the modern metal-mixer by carrying out in it greater preliminary purification than is usually the case in present practice. The bearing of these suggestions on the development of the open-hearth process is also considered. Lastly, the thermochemistry of open-hearth ore reactions is discussed.

Prof. W. A. Bone (Leeds) and Dr. R. V. Wheeler (Manchester), who in 1907 read before the institute a very important paper on the use of steam in gas-producer practice, read a paper describing further experiments demonstrating that with still lower steam-saturation temperatures a most effective combination of high rate of gasification with thermal efficiency can be continuously maintained over long periods of time, under ordinary works conditions, furnishing a rich gas of high carbonic oxide content, and eminently adapted for either power or heating purposes.

The paper read by Prof. H. E. Armstrong, F.R.S., on the scientific control of fuel consumption, was a plea for the introduction of a new attitude towards problems of combustion and of fuel economy, an attitude of understanding based upon sympathetic and serious contemplation of the phenomena. In order that economics may be effected, it will be necessary to secure the services of a special class of chemists—of men gifted with real chemical feeling qualified to study the problems which the consumption of fuel affords. Such men must be properly paid, and in every way rank on an equality with members of the engineering staff. They should have enough knowledge of engineering to be in full sympathy with their engineering colleagues, who in turn should be sufficiently versed in chemistry to appreciate the chemists' behests.

The chemist was also championed in the paper on the chemical control of the basic open-hearth process contributed by Mr. Alfred Harrison (Warrington) and Dr. R. V. Wheeler (Normanton). Starting with the proposition that the basic open-hearth process is essentially a chemical problem, they indicated how far the chemist could control the process, and detailed a scheme for the complete following of the reactions taking place.

The paper presented by Prof. E. D. Campbell (Ann Arbor, Michigan), on the constitution of carbon steels, was of a most suggestive character. He reviewed the efforts that have been made to interpret the phenomena of the hardening and tempering of steel in the light of the phase rule. The analysis of the carbides obtained from martensite and from troostite in his laboratory appears to indicate marked dissociation, ionic as well as molecular, in the carbides from martensite, while the analysis of the carbides obtained from troostite would seem to indicate almost complete association and polymerisation of the dissolved carbides, since the nitro-derivatives of the troostitic carbides are as dark in colour as those obtained from equal amount of carbides derived from pearlite. These results would indicate the probability that when martensite is heated from 0° C. to 200° C. there is progressive association of ionically dissociated carbides, and polymerisation of the carbides of lower molecular weight into those of high molecular weight. This polymerisation of dissolved carbides is apparently complete by the time the metal has been converted into troostite. This conception of the changes which take place in the gradual conversion of martensite into troostite offers a simple and rational explanation of the progressive darkening of martensite with rising temperature from 0° C. to 200° C., and for the increase of what Heyn and Bauer term free carbon, but which is probably a condensation product of olefines of high molecular weight. It is suggested that there does not seem to be any inherent reason why the complete substitution of hydrogen by iron should prevent carbon atoms from assuming relations to each other similar to those which they hold in hydrocarbons. The conception of the carbon compounds of iron as metallic derivatives of hydrocarbons suggests a possible explanation of many unsolved problems in the metallurgy of steel, as, for instance, how other elements, too small in amount in themselves to affect profoundly the properties of the steel, may enter into the carbon compounds, and, by altering their constitution, bring about effects on the steel as a whole entirely out of proportion to the amount of the element present.

The paper communicated by Prof. H. C. H. Carpenter (Manchester University), on the freezing point of iron, showed that in the present state of pyrometric science the freezing point of iron is best defined either on the thermoelectric or the optical scale. The mean value calculated from several closely agreeing determinations made under entirely different experimental conditions by the thermoelectric method is 1505° C. on the thermoelectric scale. This corresponds to 1519° C. on the optical scale, which is probably the nearest approximation to the true value at present available. The optical determination of the freezing point by a surface-radiation method does not, in its present condition, yield more than an approximate value, which is slightly lower than that obtained by the thermoelectric method, viz. 1505° C. The freezing point is independent of the atmosphere in contact with the iron, whether this be oxygen, nitrogen, air, carbon monoxide, carbon dioxide, hydrogen, or mixtures of these.

Mr. A. Jouve (Paris) contributed a paper on the influence of silicon on the physical and chemical properties of iron. In it he devoted special attention to the modification of the magnetic properties and of the chemical properties in relation to the resistance of iron to the action of chemical reagents. He gave examples showing that in cases where the silicon added to the iron attains a sufficiently high percentage the magnetic properties diminish, and the resistance to the action of acids increases with the proportion of silicon.

During the meeting visits were paid in the afternoons to the various iron works in the district and to the new graving-dock works on the river Tees. The social functions included a conversazione in the Town Hall, a ball given by the reception committee, a garden-party given by Lady Bell, a special performance at the Grand Opera House, luncheons in the Town Hall, and a luncheon given by the Tees Conservancy Commissioners at the Fifth Buoy Lighthouse.

## *FISHING AND SEA-FOOD SUPPLIES OF THE ANCIENT MAORI.*

IN the second Bulletin of the Dominion Museum of New Zealand, the director, Mr. A. Hamilton, contributes an elaborate monograph on the fishing and sea-food supplies of the ancient Maori, based upon the investigation of numerous coastal kitchen-middens and camp sites. The importance of these sources of food supply is clearly illustrated by the Maori mythology, which abounds in tales of sea adventure and monsters of the deep. Among the mammalia, the only class affording food or valuable spoil, except the native rat and the imported dog, was the marine fauna, including the fur-seal, sea-leopard (*Ogmorhinus leptonyx*), and the sea-lion (*Macrorhinus leoninus*), of all of which traces are found in the middens in the form of bones and ornaments made from their teeth. One of the most valued prizes was the great sperm-whale (*Physeter macrocephalus*); but other members of the same group, such as the black-fish (*Globiocephalus melas*), were used for food. Of mollusca the consumption must have been enormous, one of the many middens consisting of shells of the Maori pipi (*Mesodesma novae-zealandiae*) being 340 feet long and more than 4 feet high. Many of these shells, particularly that of the beautiful Holiotus iris, were used in the preparation of ornaments. Among the crustaceans, the most valued were the red crayfish, crabs, and shrimps. Sea-urchins and many kinds of seaweed were collected from the rocks.

FIG. 1.—Large Wooden Hook for Shark.

The variety of fish-hooks in greenstone, bone, or steatite is astonishing. Some objects of similar form seem to have been used as amulets, over which charms were recited to bring luck to the owner when he went fishing. This explanation accounts for some curious conventionalised examples, the use of which is otherwise not apparent. Like these are the remarkable greenstone pendants in the shape of an eel, which seem to have been employed for a similar purpose. The luck of the fishing community was also embodied in certain stones. When one of these was stolen, so recently as 1894, the natives attributed an unsuccessful season to its loss.

In the sandhills many tools have been recovered which were used in preparing bone fish-hooks. The material was worked into shape by the use of a drill moved by the alternate pulling of strings attached to the top of the spindle, the end of the drill being armed with a point of flint or quartz. When the hook was roughly shaped it was finished with rude sandstone files. The smaller hooks are usually formed of a single piece of bone, only one remarkable specimen of a small composite hook having been recorded, though large examples are common. Sharks were captured in a net or with an immense wooden hook, young roots or branches being sometimes artificially bent while growing for this purpose. Still ruder are the double-pointed pieces of albatross bone, round which the bait being wrapped they were used as "gorges"—one of the most elementary of fishing implements, common in the European lake dwellings. When the explorer and whaler came upon the scene these bone and stone hooks were quickly replaced by those of iron or copper; but the ancient forms were reproduced in the new materials. A curious appendage to a fishing-rod is a carved figure to the lower part of which a number of valves of shell were attached. These rattle when a fish takes the bait and attract the attention of the fisherman. The net-sinkers form a large class. One specimen at Auckland, formerly described as a sea-god, seems to belong to this class, the sinker being worked into a semi-human shape and used to produce magical effects. The various kinds of modern fish-baskets and nets display considerable ingenuity and constructive skill.


FIG. 2.—Figure carved on a fishing-rod.

Among the inland fish the ancient Maori depended chiefly upon the eel, which more than any other kind of food provided the much desired fat. For its capture they constructed huge works, only excelled in magnitude by their fortifications, in the shape of canals and weirs. They were well acquainted with the art of drying superfluous fish in huge earth ovens erected on the beach, and heated with a special kind of wood. When sufficiently cooked, the fish were taken out, as far as possible unbroken, placed on raised stages to dry, and finally packed in large flax baskets for winter use.

Mr. Hamilton's monograph, which is well illustrated throughout, is an interesting contribution to the study of the commissariat and industries of primitive man.

## *CHEMICAL DATA FOR THE GEOLOGIST.*[1]

GEOLOGY, as has sometimes been said, is less a distinct science than the meeting-ground of all the sciences as applied to a distinct object, viz. as elucidating the history of the earth and its inhabitants. The working geologist therefore feels, more than most of his brethren, the necessity of gaining some acquaintance with numerous branches of knowledge in which he cannot pretend to be a specialist. In particular, the problems of physical geology and petrology are closely bound up with the modern developments of inorganic chemistry, and require not only a familiarity with general principles, but a knowledge of specific results, scattered through the pages of many journals and transactions of societies.

It is with results, rather than with principles, that the work before us is concerned; and the author has gathered into one volume a large body of information which is not to be found elsewhere in collected form. The work is necessarily that of a chemist rather than a geologist, but

1 "The Data of Geochemistry." By Frank Wigglesworth Clarke. Bull. No. 330 United States Geological Survey. Pp. 716. (Washington, 1908.)

Mr. Clarke's mineralogical researches and his connection with the laboratory of the United States Geological Survey well qualify him for a task of this kind.

The volume begins with a brief notice of the chemical elements, as regards their distribution and relative abundance in the known part of the globe, a subject to which the author has himself made some interesting contributions. Then follows a valuable summary, from the chemical point of view, of the nature of the atmosphere, the waters and saline contents of rivers, lakes, seas, and springs, and the gaseous constituents of igneous rocks, volcanic emanations, and fumeroles. A large number of analyses of air, waters, and gases are collated, and their bearing on some of the questions of physical geology indicated, with an occasional discursus upon such subjects as the composition of the primitive atmosphere and the source of volcanic water and gases.

This occupies one-third of the volume. About half as much space is devoted to igneous rocks and their constituents. In this department any trustworthy data, beyond chemical analyses, are at present very scanty. The admirable work of Day and others at Washington, while providing us with accurate thermal constants for a few of the rock-forming minerals, has at the same time discredited practically all previous results in the same line. It appears, for instance, that the melting-point of anorthite, one of the most easily crystallised minerals, has been underestimated to the extent of 400°. The account here given of the several rock-forming minerals is accordingly little more than what is to be found in any text-book, excepting that the information concerning artificial reproduction of the minerals is brought down to date. The space might have been more profitably filled by a section written on the lines of the "Synthèse des Minéraux et des Roches" of Fouqué and Michel-Lévy. The fifty pages dealing with igneous rocks, under a peculiar scheme of classification, might well have been omitted. No useful purpose is served by selected analyses of rocks in a work of this kind, when complete collections of analyses are easily accessible.

The remaining chapters treat of the decomposition of rocks, sedimentary and detrital rocks, metamorphic rocks, metallic ores, the natural hydrocarbons, and coal. Under the last two heads especially there is a large amount of information which we have not seen elsewhere brought together in so complete a form.

The United States Geological Survey, taking a liberal view of its province, has from time to time issued publications dealing with general geological subjects, and among these the one now before us will take its place as a useful work of reference. It will be the more valued because the material is presented in a concise form, and the volume is of such size as to be easily handled without the aid of a lectern.

A. H.

## THE INFLUENCE OF HUMIDITY ON RESISTANCES.

MESSRS. ROSA AND BABCOCK, at the Bureau of Standards, found that manganin wire resistances used in resistance boxes varied according to the time of the year; for instance, in summer they were 0·015 per cent. to 0·025 per cent. higher in value than they were in the same temperature in winter. These experimenters explain this periodic variation by the fact that with increased relative air humidity the shellac, especially that between the metal tube and the wire, swells; the base on which the wire is wound consequently increases in diameter, and the forces thereby created cause the resistance wire to expand elastically. With decreasing humidity the shellac gives off moisture and shrinks, the pressure on the wire is relaxed, and the resistance decreases.

Tests just completed, and the results published (*Zeitschrift für Instrumentenkunde*, August), by the Reichsanstalt go to confirm this view, but the variations observed there are much slighter than those found at the Bureau of Standards. The tubes on which the wire is wound had hitherto been covered, first of all, with a sheet of silk, this being well covered with shellac; but in view of the humidity effect, tests were made with a number of specially prepared lacquers, but, so far as obtaining one which was impermeable to moisture was concerned, the experiments were futile. The author has therefore tried the effect of rendering the tubes to a certain degree elastic in order to combat the effect of the expansion mentioned, and has found that by providing them with longitudinal slots, and also dispensing with the preliminary covering of silk, a considerable advance has been made in this connection. In one coil mentioned in the results the six slots projected on both the upper and under sides to the extent of 3 mm. beyond the windings, while in another tube the slots on the upper side projected 1 cm. beyond the wire, reaching to the same distance as the wire on the under side. These coils were measured immediately after construction, and attained a constant value in a much shorter time than did the coils constructed hitherto.

With a view to obtain the maximum accuracy, the author also suggests that the resistance boxes should be continually filled with paraffin oil of a density of about 0·86. Whether better results will really be obtained in this manner is at present the subject of experiment.

The test coils experimented on up to the present are, without exception, the long, thin form usual in resistance boxes. A few slots will not suffice for rendering more elastic the short, wide tubes used for standard resistances. It must remain for tests to ascertain what is the best form for these coils, and a research is already in hand with this obect.

The paper gives a full description of the experiments, and contains a number of curves showing the variations of a number of coils at the Reichsanstalt.

## THE OPENING OF THE MEDICAL SESSION.

THE medical year of the schools of medicine in London and the provinces may be said to commence on or about October 1, and the opening of the session is in many instances made the occasion for the distribution of prizes, the delivery of addresses of welcome and advice, and the re-union of old friends at the "old students' dinners."

At University College, after the distribution of medals and prizes by the Dean, Dr. Batty Shaw, Sir Edward Fry addressed the students and their friends. He first offered his congratulations on the admirable buildings in which the work of the school is now carried on, and then made some remarks on the professional ideal. The advantage of a profession over a trade is that it sets a higher ideal before a man; it requires of him to benefit the persons for whom he acts without regard to any private interest of his own. The legitimate gain which must accrue will be a secondary object rather than a primary one. It is on this ground that, quite justly, the world expects of professional men a higher standard of intelligence and of morals than it requires of the mere tradesman. Every true student should be a student all his life through; he should be able to say with old Solon, "I grow old always learning many things." Finally, Sir Edward touched on the relation of the medical profession and the State, pointing out that it is obvious that the medical profession is becoming more and more occupied with public business, and that its aid is being more and more invoked by the governing authorities. He referred to the investigations that are being made by the direction of the Privy Council, the various commissions that are being issued dealing with tuberculosis and other aspects of disease, the scheme now being put into practice for the medical examination of scholars in the primary schools, and the appointment of medical officers of health throughout the country. The medical profession is being drawn in an increasing degree closer to the work and objects of the State. However close that relationship may become in the future, it is hoped that the medical profession will strive to maintain its independence, and will never believe that it is to be subservient to the State.

At King's College Dr. Alexander MacAlister delivered an address on fifty years of medical education. After referring to some of the salient discoveries during this period, he pointed out that each decade since has witnessed a lengthening of the course, an increase in the number of subjects of examination, and a greater stringency in the standard required. The modern curriculum is an attempt to realise a scientific ideal. At every stage practical work goes hand in hand with the teaching of theory. The result is that, even with the present five years' minimal course, anatomy, instead of being, as it used to be, the one dominant subject of drill, has to take its place as one out of five sciences in which laboratory work has to be done. He then made some remarks on the mystery of life, holding that the physicochemical hypothesis of life which has come into vogue is inadequate. Evolution is the name we give to the modal process of growth, but we are left where we were as regards the mystery of origins, or of the forces by which this process is brought about and directed. But if the physicochemical hypothesis is incompetent to account for the mysteries of organisation, it is still more inefficient as an explanation of the psychological processes of consciousness.

Prof. Myers also delivered an introductory lecture on the aims and position of experimental psychology, at the close of which he dealt with what he described as the inadequate provision of the University of London for the teaching of psychology. The subject is recognised in six separate courses of study in the University; this distribution is harmful to its progress. It is an independent science with methods which are distinctly its own. Yet there is no body of professed psychologists within the University. He pleaded for the institution of a board of studies in psychology in order that the teaching of the subject may be reorganised and coordinated. Describing the provision made for the teaching of psychology on the Continent and in the United States, Dr. Myers showed that London is conspicuously backward, and he said there are not more than half a dozen medical men in the country who could carry out such observations upon a patient as would satisfy a psychologist.

The Huxley lecture, on recent advances in science and their bearing on medicine and surgery, was delivered at Charing Cross Hospital by Sir Patrick Manson, F.R.S. The lecturer dealt first with the geographical limitation of disease and the factors causing it—local and climatic conditions, the presence of other forms of life which act as intermediaries for the germ, &c. The principal tropical diseases are caused either by protozoa or by helminths. So far as we accurately know, none of the disease germs of strictly tropical diseases is bacterial. Several bacterial diseases which are often classed as tropical—for example, cholera, certain kinds of dysentery, leprosy, plague, Mediterranean fever, &c.—are not really tropical. Experience has shown that these diseases can flourish in any climate. It is only because those hygienic and social conditions most favourable to their spread are met with at the present day in greatest perfection in the tropics that they are conventionally regarded as tropical.

At St. George's Hospital Dr. Slater took as the subject for his address the laboratory in medical education and practice, in which he demonstrated the growth of knowledge of morbid states consequent on investigations carried out in the laboratory. It is quite certain that if the maximum benefit is to be derived from the laboratories, consultations between the clinician and the laboratory will have to be more resorted to.

At the Middlesex Hospital Mr. Rudyard Kipling presided, and Dr. Kellas delivered an address on the development of medicine as a science, giving an interesting account of the history of medicine from the earliest times.

At St. Mary's Sir John Broadbent remarked on the great advances that have been made in medicine, as in surgery, in recent years, and deplored the tendency of modern times to fly to the so-called remedies for every ill now advertised widely in the daily Press.

Addresses were also delivered at the London School of Medicine for Women by Dr. Sainsbury; at University College, Bristol, by Sir Rubert Boyce; at the University of Manchester by Sir Clifford Allbutt; and at the Pharmaceutical Society by Mr. Harwood Lescher.

## *THE BRITISH ASSOCIATION.*

### SECTION L.

#### EDUCATION.

Opening Address by Prof. L. C. Miall, D.Sc., F.R.S., President of the Section.

*Useful Knowledge.*

I propose to speak to you about useful knowledge, and you will, I think, admit the importance and the appropriateness of the subject. But you may be surprised that I venture upon so wide a theme. For my part, I maintain that the extent of a subject gives no notion, however vague, of the time required to discuss it. If you have a quarter of an hour and a sheet of paper you may employ them with about equal probability of success in delineating a hand's breadth of greensward, or the British Isles, or the whole world. Bossuet handled universal history from his own point of view in a volume of no more than six hundred octavo pages, and Buffon [1] remarks, quite truly, that every subject, no matter how vast, can be treated in a single discourse. You will observe with satisfaction that I deny myself the commonest and most plausible excuse for an unduly prolonged address; that, I mean, which pleads the magnitude of the subject.

I do not wish to exaggerate the importance of useful knowledge. It is not everything, nor yet the highest thing in education. There are things which we rarely mention in a British Association section, and which are perhaps best left undiscussed, except where there is entire sympathy between speaker and hearer; some of these stand above useful knowledge of every kind. But the fact that useful knowledge occupies nearly all the school-time shows its practical importance, and disposes us to welcome any means of making it more effective.

*Book-learning.*[2]

The knowledge of books may be an excellent form of useful knowledge; it may also, when it strives merely to record and remember, be unproductive and stupefying. Let me give you an example, by no means an unfavourable one, of the book-learning which becomes sterile for lack of method and aim. My example shall be the elder Pliny, Pliny the naturalist, who lost his life in an eruption of Vesuvius, and whose many virtues were piously described by his nephew, Pliny the younger. The elder Pliny wrote a voluminous Natural History, and left behind him 160 books of unused extracts. His appetite for reading was insatiable. Reading filled all the hours which could be spared from public duties or snatched from sleep. Once, when a friend interrupted the reader to correct a mispronunciation, Pliny asked, "Did you not understand?" "Yes." "Then why did you interrupt? You have made us lose ten lines." The Natural History compiled during years of such reading is wholly uncritical; any testimony is good enough for the most improbable story. We look in vain for interpretation, combination, or inference. The facts are indeed rudely sorted, usually according to subjects, but sometimes alphabetically. The chief use of Pliny's Natural History has been to promote the fabrication of more books of the same kind.

Pliny, with his unlimited appetite for knowledge and his very limited power of using it, might seem to have been taken as a pattern by scholars. Like him, they have amassed knowledge in heaps. It has been the ambition of many scholars to read everything that was worth reading, and to fill great volumes with the imperfectly digested fragments.

In the ages of learning, the schoolmaster too became a pedant. His chief duty he supposed to consist in furnishing his boys with knowledge which they might some day

[1] "Discours à l'Académie."

[2] In the preparation of this Address I have been much embarrassed by the inexactness of the terms used to denote different studies. Some, such as science, literature, &c., include both process and product, which is as if we had but one name for weaving and cloth. The accepted names of the divisions of knowledge are neither exhaustive nor mutually exclusive; they are not so much logical terms as names of occupations, each of which might well occupy one man's time. We acquiesce in such anomalies because we feel the need of brief and comprehensive expressions, and find that bad definitions are not so intolerable as cumbrous and unfamiliar terms.

want. If it were not that Nature has endowed schoolboys with a healthy power of resistance, their memories might have come to resemble the houses of those who believe that whenever they throw a thing away they are sure to want it again—houses in which room after room is so packed with antiquated lumber as to be uninhabitable.

The Renaissance called up men who made a vigorous protest against unused learning. Rabelais put into grotesque Latin his opinion that the most learned scholars may be far from the wisest of men.[1] Montaigne said over again in pointed phrases what common-sense people had been saying for ages, that he who knows most is not always he who knows best; that undigested food does not nourish; that memory-knowledge is not properly knowledge at all.[2] Erasmus wondered at the practical ignorance of the scholars of his own days—" Incredibile quam nihil intelligat litteratorum vulgus." Locke refused the name of knowledge to book-learning; real knowledge, he held, was mental vision. In the educated man he valued virtue, wisdom, and breeding (manners), ranking them in this order; learning came last of all.[3]

Happily for us, a great deal that we once knew and might foolishly wish to keep quickly fades from the memory. I picture to myself a stream gliding past, and bearing along a miscellany of facts any of which may possibly be useful at some future time. Now and then we stretch out a hand and grasp something which takes our fancy. In nine cases out of ten we drop it immediately. Only a small fraction of the knowledge which enters the mind of an inquisitive person is kept for so long as a month.

What we remember so greatly exceeds what we can use that we need not deeply regret the loss that is always going on. When people explain to us how much valuable substance is wasted by want of care in selecting and preparing our food, I reflect that all of us consume twice or thrice as much food as we can do any good with, and then I am consoled. It is not nearly so necessary to know more things as to know them better, to know what to do with them.

No doubt we often find it necessary to recall a multitude of small facts, in order, it may be, to elicit a general conclusion or to produce a telling argument. But is it wise to prepare years in advance by storing all the facts in the memory? I cannot think so. The study of the bodies of animals teaches us that muscle and nerve, which are easily fatigued and require an abundant blood-supply, are never employed in Nature where bone or tendon will serve. Exercise of the memory involves nervous strain, and after an early age a considerable nervous strain. It is more economical and more business-like to employ mechanical contrivances rather than brain-tissue for such purposes, to leave the vast mass of useful facts in grammars, dictionaries, and text-books, and to collect those for which we have a present use in the notebook or the card-index. There is another appliance which the serious student finds almost as useful as the notebook or the card-index—I mean the waste-paper basket.

The history of learning warns us that it is not good to lay up in our memories a great store of knowledge the use of which lies far in the future. Apply to knowledge what moralists tell us about money. It is only the money that you may expect to put to use within a reasonable time that does you any good, and the same holds true of knowledge. Unused knowledge, like unused money, becomes corrupt. Uncritical, ill-mastered knowledge is at its best a knowledge of useful things, which, as Hazlitt points out,[4] is not to be confounded with useful knowledge.

If I felt it necessary to show that all book-learning is not futile, I might dwell upon the great subjects of languages and history. But you will gladly allow me to pass on to branches of useful knowledge with which I am more familiar.

[1] "Magis magnos clericos non sunt magis magnos sapientes" ("Frère Jean des Entommeures in Gargantua," i. 39).
[2] "Essais," i. xxv.
[3] Rabelais, Montaigne, and Locke have been collated by Quick in his edition of the "Thoughts concerning Education."
[4] "Round Table," Classical Education.

*Science.*

It is the function of science to produce verifiable knowledge. Science achieved her earliest successes by investigating the simplest properties of tangible things—number, form, uniform motion. Here she learned how to combine the knowledge of many concrete facts into general statements, which (to the confusion of thought) we call scientific *laws*. Science applies her general statements to new cases, using facts to make general statements, and general statements to discover or verify facts, so that a considerable part of scientific knowledge is in perpetual use. Science is no longer content with the study of simple properties and tangible things. She will consider facts of every kind as soon as she can find the time. There is no hope of withdrawing from scientific treatment any kind of experience which the human senses or the operations of the human mind furnish; to be safe from the inroads of science you must betake yourself to some study which does not meddle with facts.

Generalisation involves incessant reference of effects to their causes. Facts can only be ill-classified and superficially generalised so long as the causes of the facts remain uninvestigated. Science of any good kind sets up, therefore, the habit of methodical inquiry and the habit of reasoning—productive reasoning, we might call it, to distinguish it from the reasoning of the schools. The best examples of productive reasoning are to be found in the investigations of science, and especially of those experimental sciences which deal with simple tangible objects the properties of which can be studied one at a time.

The virtues of science are exactness, impartiality, candour. Scientific impartiality means the determination to accept no authority as binding except the assent of all competent persons. Scientific candour means perpetual readiness to revise opinions which are held in respect. Loyalty, except of one kind, loyalty to herself, science has no use for and does not cultivate.

I think it is true, but you can judge as well as I, that during the last four centuries there has been no generator of useful knowledge at all comparable with science.

*Spencer's Estimate of the Place of Science in Education.*

Herbert Spencer has raised the question: What knowledge is of most worth? He considers knowledge in its bearing on life and health, on the gaining of a livelihood, on citizenship, on artistic production and enjoyment; lastly, as a means of discipline. The answer which he gives under each head is "Science"; that is his verdict on all the counts. A decision so clear, which is, moreover, powerfully and even eloquently supported, cannot fail to be impressive. It is naturally welcome to those who are devoted to the cause of science, and we can all see that, if accepted, it will simplify many troublesome questions. Will it not guide us in choosing a school staff, in drawing up a curriculum, in fixing the future occupations of our children?

But we must first scrutinise the verdict itself. Let us begin by putting a preliminary question so as to remove all risk of ambiguity. Who or what is to possess the knowledge the worth of which is to be estimated? Spencer seems to contend that for everybody and in all possible circumstances science is that knowledge which is most valuable, but this is a conclusion hard to receive. There are persons who are intellectually unfit to acquire the scientific habit of mind, or who follow an occupation incompatible with any but a light and recreative study of science. Suppose that a youth is wholly uninterested in science; or that after fair trial he shows no capacity for it; or that he is eager to become a poet; or that he will inherit a lucrative business in which science plays no part; would not these propensities and circumstances modify our choice? I cannot believe that Spencer was so unpractical as to deny them any weight at all. Is it possible that he was thinking of mankind, of the British nation, or of some other large collection of men; that it is to the nation or the race that science will prove itself of most worth? If this is the right interpretation, we have some ground for blaming Spencer's neglect to mention so important a qualification. Those who admit that the nation requires scientific knowledge beyond knowledge of any other kind are not compelled to maintain that the individual man must give his chief attention to science. A minute division of labour, intellectual as well as manual, is necessary in modern life, and we become every day more dependent upon other people's knowledge. An elementary knowledge of many sciences, such as Spencer valued and himself possessed, steadily becomes less attainable, and less applicable to real business; less attainable, because the standard is always rising; what was a respectable acquaintance with science in the days when Spencer was educating himself would now be thought no better than a smattering; less applicable, because business now requires and commands the science of experts. The instances which used to be quoted half a century ago of workmen who attended a course of chemistry in a mechanics' institute, and straightway suggested improvements in the manufacturing processes upon which they were engaged, have become rare, and will soon disappear altogether. Business demands the very best science that the age can supply, and it can afford to pay high enough to get it. Obviously the best knowledge of any kind can only be possessed by a few.

Spencer seems to expect that every intelligent mother should enjoy a knowledge of human physiology which will be a sufficient practical guide for the rearing of a family, but here, too, I have my doubts. Since the first publication of his essay the requirements of human physiology have risen in a surprising degree. The knowledge that can be got by reading even so admirable a text-book as Huxley's "Lessons" does not nearly suffice for the practical adviser. On this point I can speak with experience. When I was preparing for biological work I dissected the human body, took out courses in physiology, and walked the hospital. But this tincture of professional knowledge, though better than that which any elementary or secondary school could supply, has never proved applicable, except to the least serious of emergencies. A little knowledge may indeed be dangerous when it is applied to the diagnosis of disease or to sanitary construction.

Those who agree with me that the science which is applicable to industry or to public health is steadily growing harder of attainment will not, I hope, turn this into an argument for restricting the study of science to a few. The elementary science of the school, if good of its kind, is valuable for its effect upon the character and the intelligence; it is necessary for the timely discovery of young people who can be trained to carry on scientific discovery; and it engenders a sympathy with science which is of high importance to the State. If the science of the school does no more than make the phenomena of everyday life a little more comprehensible and a little more interesting, it will fully justify itself.

Spencer would, I feel sure, have admitted that even when science is to be the chief occupation of after-life, it should not occupy more than part of a well-ordered course of school-study. The chemist or physiologist often requires to express his own meaning by speech or writing; it will be highly advantageous that he should express it clearly and vigorously. He must get effective command of at least one foreign language. He ought to know enough mathematics and drawing to make his own calculations and sketches. He ought to have learned how to use books. Spencer does not exclude literature and the fine arts from education, but in his scheme they are not to claim very much. "As they occupy the leisure part of life, so should they occupy the leisure part of education."

I do not suppose for a moment that this passage was written with the intention of pouring contempt upon literature, and it is really appropriate to the current fiction which to-day is, and to-morrow is cast into the oven, but what insensibility to the claims of the higher literature it betrays! "On traite volontiers d'inutile," says Fontenelle, "ce qu'on ne sait point; c'est une espèce de vengeance."[1]

These considerations move me to reject Spencer's verdict. There is not, and cannot be, a scale of usefulness by which everybody's choice can be at once determined. Before deciding what the schoolboy is to study we must inquire what are his aptitudes, inclinations, and opportunities. And the importance of science, which I do not think Spencer has exaggerated, will be fully recognised when every nation and city, every profession and trade, every person and interest, can be guided as often as need arises, not by their own scientific judgment, but by the judgment of scientific experts.

[1] Dr. Duncan's "Life" furnishes proof of the slightness of Spencer's obligations to literature.

### *Preliminary Scientific Medical Studies.*

Everyone agrees, in the abstract, that scientific information, the heap of scientific facts, is a small matter in comparison with scientific method and the scientific spirit. We do not, it is true, give effect to our convictions in practice. The teacher of science still loads the memory with facts; the examiner in science still passes or ploughs according to the quantity of facts that the candidates have got up. It requires an effort to keep hopeful, but we must go on steadily pointing out what we take to be the right way. The reformers of science-teaching are now bent upon such improvements as these: they wish to see a greatly improved synthesis of the student's knowledge, so that the things that he learns in one place and from one teacher should be intimately combined with what he learns in another place and from another teacher. Further, they wish to see a large extension of personal inquiry and personal verification of the fundamental scientific facts. It is thus, we think, that the future man of science will become possessed of a compact and harmonious body of useful knowledge, which may in favourable cases incorporate with itself the experience of after-life, and exhibit the incomparable virtue of healthy natural growth.

I will continue the discussion a little further with reference to the great problem of the scientific education of the medical practitioner, which has occupied the attention of the scientific world during the whole time of my long professorship, and still seems far from permanent settlement. Medicine is at present our one great scientific profession. It brings science into the daily life of every one of us, and employs it for the protection of some of our dearest interests. The scientific basis of medical knowledge should be sound, compact, well mastered, and, if possible, productive. I will go on to consider what it actually is, forming my opinion upon thirty years of experience in teaching elementary science to medical students.

Let me begin by making a concession to those who think that things are pretty well as they are. Remembering distinctly what the medical student was thirty years ago and more, I find that the first-year's university student of medicine at the present day is in all respects a better man, more serious, more enlightened, more capable. I find too that his preliminary scientific course seems to do him real good. It is far from perfect, but it is a great improvement upon anything that existed in the remote days when I was myself a first-year's medical student. The labours of the last thirty or forty years have not, in my opinion, been thrown away.

Nevertheless the preliminary scientific studies of the medical man are far from being as effective as they ought to be. Much of his time and effort are spent in laying up heaps of knowledge for which he is expected to find a use at some distant day. The items of scientific knowledge still require to be firmly bound together, and indissolubly associated with professional ideas and with professional exigencies. It is only close association with the work of the practitioner that can keep his knowledge alive.

The preliminary scientific course should give practice in the methods of chemistry, physics, and biology. It should prove by definite evidence characteristic scientific truths. Lastly, it should be closely related to medical practice. Looking round for an inquiry which will satisfy these conditions, one inevitably thinks of the teaching of Pasteur, which is now recognised as fundamental in medicine, surgery, and hygiene. Is it possible to give the future medical practitioner a firm grip of that teaching? I think it is. The first part of the preliminary scientific year I should treat as preparatory. It ought to acquaint the student with the methods which chemistry, physics, and biology employ for the establishment or the criticism of scientific statements. Methods of detecting and estimating; of observing small indications; of drawing; of recording results; of putting questions and bending the mind to their solution, should receive particular attention. The multifarious learning of the text-books should be put aside in order that undivided attention may be given to investigation and proof. I would leave it to the teachers concerned to supply the appropriate training, and to certify that it had been got. The latter part of the same year might be concentrated upon the close study of a very few of those agents which set up fermentation and putrefaction and contagion. A simple practical examination would test the reality of the knowledge of ferments actually gained; I can only hope that the examiners would not expect encyclopædic knowledge. This is not the place for the discussion of details.

*Technical Education.*

Of technical learning I must say but little, and that little must be said with reserve. For my only acquaintance with the subject is indirect, and arises from long connection with a city and university where technical education is prominent. I hope not to express presumptuous opinions on a kind of useful knowledge which I know so superficially.

Technical education may be pursued in at least three ways: (1) We may seek to qualify the pupil for his calling by a thorough training in some science or art, and then, by the application, under the guidance of an expert, of that science or art to a particular industry. The experience of at least two generations seems to show that this method is really effective; it does what it professes to do. (2) The second method aims at no more than supplying information directly applicable to the industry in question. Surely this is the least profitable of the three. The information is not accurately lodged, either in the memory or in the note-books of the students; it soon becomes obsolete in consequence of the advance of knowledge; and it does little to cultivate intelligence or the power of doing. Where intelligence and the power of doing already exist, mere information may be valuable, but the best storehouse of information is the printed book. (3) Lastly, we may aim at nothing more than facility by repetition. Such practical arts as reading, writing, drawing, needlework, and cookery are largely acquired by imitation and constant practice. Skill in these arts is a tool, the profitable application of which depends much upon the intelligence and enterprise of the possessor. Independent attempts to meet difficulties, friendly criticism of these attempts, questioning about the causes of failure, are the expedients which a wise and experienced teacher, ever at hand, would employ. Such a teacher is of course rarely to be had, but is now and then found in a sensible mother. Perhaps the best substitute for the sensible mother would be plain, practical lessons on elementary science, such as the Edgeworths, Dawes, and Henslow used to give.

*Literature.*

Literature differs from most kinds of useful knowledge in having an immediate value. Like beautiful scenery, health, liberty, friendship, and other felicities of life, it is good in itself, apart from the advantages which it brings. Nevertheless, literature is not satisfied with delighting. Like architecture, it aims at utility as well as beauty, and employs its power of delighting to instruct and guide.

The benefits which we receive from literature are comparable with those which we receive from good society. We are expected to enjoy and appreciate; we are not to be for ever asking: "What have I got that I can carry away?" Literature may be more than good society; it may compare with the intimate talk on grave subjects of a wise and high-minded friend. Unfortunately those whose office it is to introduce us to literature often treat it as if it were only a particular sort of useful knowledge. They occupy our attention so completely with grammar, metre, etymology, and historical allusions that we have no leisure to enjoy and appreciate. Dr. Bain[1] tells us that we need to be indoctrinated in points of style before we begin to read on our own account, and discourages the reading of entire plays of Shakespeare because we come across long passages which yield no marked examples of either grammar or rhetoric.

I have little fear that the scientific age which is now upon us will be permanently hurtful to literature. No new Lucretius, it may be, will write on the Universe, no new Milton on the Creation and the Fall. But contemplative and lyrical poetry will survive all changes in our philosophy. The higher criticism, which is the study of life as well as of letters, will survive too. One literary art, the art of rhetoric, may be weakened and lost when the scientific spirit becomes predominant—that sort of rhetoric, I mean, which may be fitly described as insincere eloquence. Rhetoric seeks above all to persuade, and in a completely scientific age men will only allow themselves to be persuaded by force of reason. Even in our imperfectly scientific age those men gain most by speech who have something important to say, who say no more than they know, and who use all possible plainness.

It will be enough for my present purpose if we can agree that literature has an aim and purpose of its own, and must not be treated simply as a branch of useful knowledge. Literature and science, for instance, are incommensurable.

*The Necessity of Choosing.*

It is an intellectual luxury to run over the kinds of useful knowledge that we should like to possess. Among them come languages, ancient and modern, some giving access to high literature, some yielding historical or scientific information, some acquainting us with communities or modes of thought very unlike our own. Then come a multitude of sciences, which perhaps show the engineer how to build railway bridges, or tell the navigator how to cross the Atlantic, or help us to improve our health and lengthen our lives. I barely mention history, geography, and innumerable practical arts. We seem to be led into a well-filled treasury, and invited to say what we will have. But one unpleasant condition is laid down; we may choose what we please, but we must pay for it. A new study generally means outlay of money, and always means outlay of time. We soon find ourselves forced to behave like the man whose wife has tempted him into a fine London shop; like him, we begin to ask: "How much can I afford to spend here?"

Every headmaster and headmistress is occupied with the eternal question how to make room for all the things that are demanded of the school. Theorisers, who have no responsibility for the time-table, insist from time to time upon new additions, and are happy if they can only express their own opinions with an emphasis which satisfies their sense of justice. It is my opinion that far too much has already been conceded to demands which, reasonable when taken separately, are unreasonable when taken together. I have known the time-table of a girls' school overloaded to such a point that in one form chemistry and English literature got no more than an hour a week between them. The headmistress no doubt hated the arrangement, but had to conform.

I have said that the grounds for introducing each separate subject are often perfectly reasonable. Thus by ancient usage Latin is made a necessary subject in certain schools. Then a claim is put in for Greek as more interesting and equally important. French and German demand admission, and put forward claims which can hardly be overstated. The result is that some boys in secondary schools attempt four languages, and many attempt three. Then we usually find that no foreign language, ancient or modern, is mastered to the point at which it can be used in reading, writing, or conversation. Our wish to be fair and consistent has landed us in an absurdity. The root of the whole difficulty lies in the fact that while there are perhaps fifteen or twenty branches of knowledge eminently fit to be taught in school, no pupil can profitably undertake more than five or six at a time. The man of business who is inveigled into a shop is better able to resist importunity than the schoolmaster. He will say: "If you insist upon the drawing-room table, you must go without the chest of drawers; if you insist upon the chest of drawers, you must go without the drawing-room table." I wish that the headmaster or headmistress might find courage and strength to require that every subject admitted

[1] "On Teaching English," p. 18.

to the curriculum should come round frequently, at least for two or three years; as nearly as may be once a day, but we cannot be rigid in these matters.

The sciences taught in school may spoil one another's chances in the same way. Not a few schools are convinced that they must have chemistry and physics because of their industrial importance, hygiene because of its relation to the health of the community, physiology to make the hygiene intelligible. The schoolboy is made to buy more sciences than he can pay for, and his time is gone before he reaps any of the advantages which are so much desired.

*Too Much and too Long.*

One inevitable result is that the school hours, including the preparation of lessons, are nearly always too long. Another result is that the schoolboy who is willing, but not very clever, is often overworked. I have known many such cases myself, and have also known cases in which excellent results have been attained in a good deal less than the customary time. If we could consent that our pupils should remain ignorant of many useful things, if we could materially shorten the lessons of very young pupils, and if we could bring the home-lessons into much smaller compass, I believe that the education which we offer would really be more valuable.

*Natural and Artificial Education.*

If we had a pupil put into our hands for solitary instruction, like the Émile of Rousseau, we should find it wise to begin by studying him closely, and three things would particularly require attention—his aptitudes, his inclinations, his opportunities. The first two are self-explanatory, but the word *opportunities* may present some difficulties. It includes, of course, opportunity of learning, but the chief stress is to be laid upon opportunity of exercise in after-life. This is the opportunity which stimulates interest and rewards exertion. Moral character, intellectual character, curiosity, love of knowledge, equipment for practical life, and, so far as I can see, all considerations which ought to govern the choice of a study, come under one or other of the three requisites—aptitude, inclination, opportunity.

In school we have not so much solitary pupils as groups of pupils to consider, and this compels us to accept compromises, which are familiar to every teacher. We have often to study the wants of a school-form as well as the wants of an individual.

Some writers have given to the education which considers first of all aptitude, inclination, opportunity, the name of *Natural Education*, while that which makes its choice of studies on abstract or arbitrary grounds, with little reference to the needs of the pupil, they call *Artificial Education*.[1] We may be allowed to revive these terms for the sake of brevity. To me they seem appropriate as well as convenient in practice.

The advocates of natural education have sometimes reached absurdity by pressing the claims of one of the three requisites to the neglect of the rest. Tolstoy would make inclination supreme, even in early education. He exemplifies Quick's remark that writers on the school-course who are not schoolmasters are almost all revolutionary. Others have attended too exclusively to the opportunity of future exercise. The old grammar schools, thinking much of the future wants of the pupils who might wish to enter the Church, often added Hebrew to the compulsory Latin and Greek. Fortification was frequently taught to little boys. When the Berlin Realschule was founded (1747) it offered, among other things, instruction in the rearing of silkworms and the discrimination of ninety kinds of leather.

Nothing, I think, gives us a clearer notion of what natural education can accomplish in favourable circumstances than foreign travel, which is a form of self-education prescribed by grown-up people to themselves. Even the milder forms of compulsion are wanting here; aptitude, inclination, and opportunity are everything. The preparation, the actual journey, and the recollections yield abundance of instruction to those who use them well. For weeks before setting out the traveller will turn over maps and conversation-books, inquire about handy cameras or collecting-boxes, and study the country which he is about to visit with an eagerness which he never felt before. The journey itself, if only it be such a journey as an active mind will frame, cannot but call forth many powers, physical, intellectual, and moral, that are rarely exercised at home. The love of science, the love of languages, the love of scenery, the love of adventure, the love of society, the love of poetry, all get a new stimulus. And the journey, already profitable in anticipation and in execution, is not exhausted when we return home. Our experiences in unfamiliar countries vivify many a page of history and many a scrap of useful knowledge which would have been otherwise languidly remarked or passed by altogether. Some years ago I had occasion to read the travels in the Levant of old Belon, a French naturalist of the sixteenth century. Though I had a purpose in reading them, they made no impression, and after a few months nothing survived but some pages of dry and unprofitable notes. Then I visited the Greek Archipelago myself, and one of the things that I made a point of doing when I came back was to read Belon again. I found it an entirely new book, full of curious and valuable observations. Now I dwelt with keen interest on his account of the various nations which had made settlements in the Archipelago, on the Greek language, on the Cretan customs of wine-drinking, on the fishes and birds, and on a hundred other details which had seemed totally uninteresting before I visited the eastern end of the Mediterranean.

Let us suppose that all is done, not *by* the traveller, but *for* him, that routes are chosen, hotel-bills paid, carriages and boats hired, languages interpreted, information supplied, all without effort on his part. In a few months he will barely remember what places he has seen and what he has passed by. This may remind us that natural education is only kept alive by *doing*.

Of course the grown-up person is not like a child, and there is need of steady and impartial government, of drill, in short, if the child is to take all the pains that are indispensably necessary in school-work. All our teaching cannot be recreative. Does not this show, some of you will say, that your natural education is inadequate, and that a sterner thing, which takes little or no account of inclination, is demanded in school?

I think not. I think that inclination is a power that we ought to employ as often and as far as we can. No doubt it is inadequate; our very definition makes inclination only one of three requisites. The child at school may usefully remind us that the opportunity of future exercise in some cases becomes necessity, and will take no denial. Nevertheless, all three should be considered, and that teacher will prosper best who lets none of them drop out of sight. Do not forget, too, that inclination is the modifiable requisite; we can stimulate, and even create it; we can also fatally discourage it. It is only natural education, I still maintain, which can count upon the energetic cooperation of the child.

On the other hand, if we ignore aptitude, inclination, and opportunity—if we pour out information upon which the pupil does no work, merely because we think it ought to be good for him, then we have a dull, perhaps a sullen, mind to deal with, which neither will nor can learn to good purpose. The example for all time of artificial education is, or lately was, the setting of every boy in every grammar school to learn Latin, if not Latin and Greek.

Those who believe that natural education is at once the most formative and the most productive, that it helps to build up body and mind, that it encourages the acquisition of truly useful knowledge, should attend to one point which often escapes notice. Natural education demands leisure for the pupil. At the present moment the leisure of the pupil has been reduced to a very small amount indeed. We strive for efficiency, for good examination results, for knowledge of useful things. The negligence of the old race of schoolmasters, which winked at monstrous abuses but allowed a certain independent school-life, has been replaced by zeal and conscientiousness, which occupy every hour, and sometimes treat independent

[1] See, for example, Henry Sidgwick in "Essays on a Liberal Education" (1867).

occupations as mere idleness. Long rambles, such as were the delight of my boyhood, when we used to go miles in search of a wasp's nest, are in certain modern schools abolished by compulsory games. Some day or other (the reform will not come in my time) we shall recognise that the chief occupation of the young child should be spontaneous natural play.

That interesting book called "Public Education," now nearly a hundred years old, in which we find a description of the methods practised by Rowland Hill and his brothers at Hazelwood and Bruce Castle, is inspired by the desire to make education natural and not merely artificial; so is that older and still better book, "Edgeworth on Practical Education." There are modern English schools which give fair opportunity for natural education. I pass over some, perhaps many, out of mere ignorance; but I will name two which I happen to know—Bedales School and the Friends' School at Bootham, York, both of which have discovered how to combine natural education with efficiency.

*Heuristic Methods.*

Dr. Armstrong's heuristic method is well known in this section. He tells us that neither the name nor the thing is altogether new, and the same may be said of nearly every educational expedient. Promising schemes are proposed, tried perhaps on a small scale, and dropped, often for lack of enterprise on the part of the teachers, and years after someone discovers them again. Dr. Armstrong tells us [1] where he got the name, and quotes a passage from Edmund Burke, which clearly describes the method. It is now a good many years since I saw Mr. Heller give several lessons on this plan in elementary schools in London, and was then permanently convinced of the real value of the heuristic method. I only wish that we had a score of such, each worked out as carefully as Dr. Armstrong's model.

The method need not be confined to experimental science, nor to science at all. I have attempted something of the same kind in elementary biology. Why should not teachers of history carry out a little historical research with the help of an upper form? Suppose that the subject chosen was English town and country life in the sixteenth century. Harrison's Description of England, Shakespeare's plays, Walton's Lives, some of the modern books which collect the testimony of foreign visitors during the reigns of Elizabeth and James I., Spenser's View of the State of Ireland, and Hume Brown's Scotland before 1700 are, let us suppose, accessible to the class. Useful materials from these and any other sources might be arranged in a card-index. Cooperation is eminently desirable, and a little club of pupils might well make their index in common. Then the materials should be treated in literary form, every detail of literary workmanship receiving attention. I fully expect to be told that this plan has actually been tried in some school or other. The historical researches of the school may give opportunity for the use of foreign languages, for map-drawing, or for the handling of statistical information.

Mr. Greening Lamborn's "School History of Berkshire" [2] is interesting as an investigation carried out by and for the boys of an Oxford school. It will be read in a very different spirit from that with which the condensed school-history of England is received, and will no doubt suggest more work of the same kind. The share of the boys may well grow larger and larger.

The advocates of learning by inquiry and learning by doing will descend even into the nursery. What an opportunity is afforded by toys!—an opportunity that those who purchase all their children's toys throw away. Surely every little girl ought to be encouraged to make plausible dolls out of the rag-bag, every little boy to make his own menagerie, his own boats and whistles and sledges. Even the bought toy gives opportunity for inquiry. Ask any child if he has noticed that the animals of the Noah's Ark are always thicker at one end, usually the hinder end. There is a reason for this, and a curious reason, which the child may be helped to discover.

1 "The Teaching of Scientific Method, &c.," 1903, p. 235.
2 Clarendon Press, 1908.

*Mastery of Something.*

Let us indulge less than we do the passion of intellectual avarice, if only because avarice blinds us to the relative values of things. The old French anatomist, Méry, said of himself and his colleagues that they were like the rag-pickers of Paris, who knew every street and alley, but had no notion of what went on in the houses. The accumulation of miscellaneous knowledge of useful things, copious, inexact, inapplicable, may, like rag-picking, leave us ignorant of the world in which we live. Let us try to reach the inner life of something, great or small. The truly useful knowledge is mastery. Mastery does not come by listening while somebody explains; it is the reward of effort. Effort, again, is inspired by interest and sense of duty. Interest alone may tire too quickly; sense of duty alone may grow formal and unintelligent. Mastery comes by attending long to a particular thing—by inquiring, by looking hard at things, by handling and doing, by contriving and trying, by forming good habits of work, and especially the habit of distinguishing between the things that signify and those that do not.

It is too much to expect that mastery will often be attained in school. School is but a preparation, not I think for promiscuous learning, but for the business of life. The school will have done its part if in favourable cases it has set a pattern which will afterwards develop itself naturally and harmoniously.

## CHEMISTRY AT THE BRITISH ASSOCIATION.

An unusually large number of chemists attended the meeting, and in consequence very many papers, some of considerable importance, were read before the section. Chief interest attached to the discussions, which were well supported and of real value; it is worthy of consideration whether it be not advisable to devote the programme almost entirely to these. On no other occasion is it possible to have what may be termed "borderland problems" discussed conjointly with representatives of other sciences.

The most novel contribution to the section was that made on behalf of Dr. Mond, describing the preparation and properties of cobalt carbonyl. The preparation of this substance has hitherto been attempted in vain, though the remarkable compounds of carbon monoxide with nickel or iron have been known since 1890. It is now obtained by acting on finely divided cobalt with carbon monoxide at 100 atmospheres pressure between 150° and 200°. It forms large orange crystals, which decompose in the air, yielding a deep violet substance.

Sir William Ramsay related in popular terms the well-known story of the discovery of argon, helium and other gases in the atmosphere. Following him, Prof. Hartley described his researches on the detection of lithium in radio-active minerals, which are of importance in connection with the assumed transmutation of copper contained in solution into lithium, neon and possibly other substances. He adduced much experimental work to show that it is impossible to corroborate Sir William Ramsay's statements that potassium is a more widely distributed element than lithium, or that lithium is an unlikely constituent of dust, glass, copper, &c.

Prof. Rutherford described experimental work showing that the amount of neon in 1/15 c.c. of air readily gives the neon spectrum, and can so be detected. He attributed Sir William Ramsay's assumed formation of neon by the action of the emanations on water to a slight leakage of air during the experiment, and claimed that when air is excluded no neon is formed. Sir William Ramsay, replying, upheld his experiments, but agreed that the formation of lithium from copper was of a less degree of certainty than the other transmutations he has observed.

Sir James Dewar communicated a paper from Dr. Kamerlingh Onnes describing the apparatus used to liquefy helium. From the study of the isothermals of helium the critical temperature was found to lie between 5° and 6° absolute, indicating that the gas must be cooled below 30° absolute before it will cool on expansion. By boiling hydrogen under reduced pressure 15° absolute were obtained, and using 200 litres of helium it was possible to continue the experiment long enough to obtain liquid helium boiling at 4°·5 absolute. A temperature of 3° was reached without any sign of solidification. Dr. Onnes hopes to reach 1°·5 absolute. Sir James Dewar pointed out the intimate connection between low-temperature research and the theory of van der Waals, and gave an account of anticipations of and experiments on the liquefaction of helium, showing how statements made in his presidential address at Belfast in 1902 had proved to be accurate.

A discussion on the nature of chemical change was opened by Prof. H. E. Armstrong, who contended that dissolution involves associative and distributive changes. Water is supposed to be a complex mixture of active and inactive molecules, the active molecules being *hydrone* ($OH_2$) or *hydrone-hydrol* $\left(H_2O<^{H}_{OH}\right)$, and the inactive molecules closed systems formed by the association of two or more simple molecules. In a solution of hydrogen chloride molecules of the type $H_2O<^{H}_{Cl}$ and $HCl<^{OH}_{H}$ exist, the latter being the more prevalent in weaker solutions. The properties of aqueous solutions were explained on this hypothesis. Sir Oliver Lodge pointed out that these hydrogen chloride molecules were not very different from the hydrated ions postulated by followers of the ionic theory. Subsequently Prof. Armstrong's theory was adversely criticised by Dr. Findlay, Dr. Donnan, and Dr. Wilsmore.

The discussion on problems of fermentation was arranged to focus as clearly as possible the present state of knowledge. Dr. Harden gave an account of the present position of the zymase theory. He showed that the fermentative activity of yeast juice is due to two substances, which may be separated by passing through a Martin dialyser at 50 atmospheres pressure. The residue contains the enzyme, the filtrate the so-called co-enzyme, and these only ferment sugar when united, either separately being inactive. Sodium phosphate causes an increase in the rate of fermentation; apparently a hexose phosphate is first formed, which breaks down to fermentable sugar and sodium phosphate. Prof. Adrian Brown discussed cellular fermentation, which is generally stated to be controlled by the rate of diffusion of the sugar fermented into the cell. Under normal conditions the enzymes are inside the cell and do not leave it, but under unhealthy conditions the enzyme probably leaves the yeast cell.

Dr. A. Slator pointed out that the conversion of glucose into alcohol and carbon dioxide is a series of reactions, and that the velocity of change is determined by the rate of the slowest reaction. The rate of fermentation is proportional to the amount of yeast present, and independent of the concentration of the sugar. He suggested that glucose and fructose are fermented by one enzyme, mannose by another, and galactose by a third. Galactose is fermented only by yeasts which have been grown in the presence of galactose.

Dr. E. F. Armstrong dealt with the *rôle* of enzymes in fermentation. The mechanism is quite distinct from the sucroclastic enzymes; in the case of glucose, fructose, or mannose the first step is the conversion, by means of an enzyme, into the common enolic form, and the formation of a compound between enzyme and enolic form. He further alluded to the question of adaptation of the organism to nutrition, pronouncing in favour of the view that something which is already present, though hitherto latent, is developed in response to stimulation, and opposed the idea that an altogether new enzyme is formed. This view was developed by Prof. Gotch and Prof. Keeble. Prof. H. E. Armstrong described the recent work of F. Ehrlich, who has shown that the supposed by-products of alcoholic fermentation are in reality produced by the action of yeast on amino-acids derived from the protein complex.

Messrs. Julian L. Baker and H. F. E. Hulton contributed a preliminary note on the action of the enzymes of malt on ungerminated cereals. A considerable increase in the diastatic activity of barley takes place when it is digested in presence of malt extract.

Prof. W. H. Perkin gave a brief account of the history of synthetical progress in the terpene series, and described the methods and stages in the process of synthesis of terpineol, carvestrene, and also the first optically active terpineol. Subsequently, Dr. Weizmann dealt with the methods suggested for the preparation of synthetical camphor on a commercial scale. Under laboratory conditions many of the processes yield from 70 per cent. to 80 per cent. of the theory, but on a large scale the yield and purity of the product have frequently left much to be desired. A method was described of converting pinene hydrochloride into *iso*bornyl acetate by means of glacial acetic acid and zinc chloride.

Dr. T. M. Lowry gave an account of the work done by the committee on dynamic isomerism. The most important feature of the year's work has been the discovery of a group of agents by means of which isomeric change—in the case of camphor derivatives—can be retarded or completely arrested. Such are carbonyl chloride and acetyl chloride; the action of the former probably depends on its power of converting ammonia and bases, such as piperidine, into neutral carbamides. The relationship between absorption spectra and isomeric change has been tested in the case of a number of optically active camphor derivatives.

A further case of dynamic isomerism observed in derivatives of oxymethylene camphor was described by Prof. W. J. Pope and Mr. John Read.

Dr. J. A. Smythe dealt with problems of tautomeric change in a paper on the reaction between benzyl sulphoxide and hydrochloric acid.

Matter of very great interest was contained in a paper by Prof. Adrian Brown on the selective permeability of certain seeds. The coverings of grains act as semi-permeable membranes towards sulphuric acid solutions; water passes into the grain, and the acid solution becomes more concentrated. The membrane prevents the passage even of 36 per cent. acid, but in this case water passes out of the grain to dilute the acid. The membrane is likewise impermeable to most salts. Iodine, however, does pass through, also mercuric chloride and cyanide, but no other mercury salts. Organic acids, such as acetic acid, pass through the membrane, but not lactic acid. The grains thus exercise selective permeability, the permeable compounds being non-dissociated or only very slightly dissociated.

A report on colloidal chemistry was presented by Prof. Procter, and approved for printing *in extenso*. This deals very fully with the properties of colloids and with the history of the more recent development of the subject, the industrial importance of which is being gradually recognised. Not only are tanning and dyeing particularly concerned with the mutual precipitation of colloids, but such industries as rubber, gums, dextrin, glue, and cellulose are all colloidal, as also many inorganic industries, *e.g.* glass manufacture and pigment making. Such a summary is very opportune at the present moment.

Dr. A. Findlay gave a preliminary account of an investigation of the influence of colloids on the absorption of gases by water, a subject which has a bearing on the absorption of carbon dioxide by blood. Most of the colloids studied had relatively little influence on the solubility of carbon dioxide in water.

Prof. Pope and Mr. Wm. Barlow gave a short account of their theory of valency as applied to elucidating the structure of the open-chain hydrocarbons. This was illustrated by some excellent models. The subject of valency was further dealt with from a theoretical point of view by Mr. H. Bateman, who defines valency as a number which indicates the degrees of freedom for departure from the existing state of motion of the charged particles which constitute the element.

Dr. J. Timmermans showed an apparatus and described investigations on the densities of liquids from 0° C. to their melting points in continuation of Young's experiments on the rectilinear diameter.

Dr. H. J. S. Sand gave a demonstration on the rapid electro-analytical separation of metals with the apparatus described in the Journal of the Chemical Society. A somewhat similar apparatus was briefly described by Dr. F. M. Perkin.

Interesting results obtained with transparent silver and other thin metallic films were shown by Prof. T. Turner. Thin gold leaf becomes transparent when heated to about 550°; the change does not depend on the nature of the atmosphere. Thin silver leaf requires the presence of air or oxygen for a similar change. Thin sheet copper, heated to 200°, becomes transparent, and transmits yellow-green light quite freely.

A discussion on the practical utilisation of peat was opened by a paper from Dr. Woltereck, dealing with the production of ammonia from atmospheric nitrogen by means of peat. Experiments have shown that a mixture of nitrogen and hydrogen passed over reduced iron at a low heat produces ammonia, and that the presence of oxygen and water was of importance. Finally, the hydrogen was omitted and peat substituted for the iron with satisfactory results. It is claimed that atmospheric nitrogen cooperates in the formation of ammonia. Subsequent speakers included Prof. Ryan, Prof. Turner, Sir James Dewar, and Mr. K. B. Eller, but the discussion failed to bring out any new facts of importance.

The aromatic nitroamine committee (secretary, Dr. K. J. P. Orton) reported on the transformation of nitro-amino-benzenes into nitro-anilines. The influence of the solvent, nature of the acid catalyst, and the effect of concentration of the acid and temperature have been studied.

The report of the committee for the study of hydro-aromatic substances (secretary, Prof. A. W. Crossley) contained the usual valuable summary of recent work in this field, together with new investigations on dimethyldihydrobenzene.

## *GEOLOGY AT THE BRITISH ASSOCIATION.*

The geologists who were privileged to attend the meetings of Section C at Dublin will always recall with pleasure the kindly welcome and helpful assistance extended to them by the home geologists. Not only did they give us a president whose brilliant address promises to be historic, and arrange for our benefit a delightful series of excursions in the neighbourhood of Dublin, but they communicated many papers of great interest, and took a very active part in the work of the section.

Prof. Cole's lecture on the geology of the country round Dublin, which followed the president's address, summarised the principal points of interest in the district, and led us to a clearer view of the many important features we were enabled to see in the afternoon excursions organised and led by Mr. H. J. Seymour and others.

Prof. Cole also contributed two other papers, one dealing with the examination of the stones brought up during the dredging expeditions of the Fisheries Branch of the Department of Agriculture and Technical Instruction for Ireland. The discovery, off the coast of Kerry, of abundant flints, chalk, glauconitic chalk, and Milioline limestone showed that the Cretaceous and Eocene seas extended to an unknown distance towards the west.

The other paper was explanatory of an exhibit of the types of rock formed during the intervals between the basaltic eruptions in the north of Ireland in Eocene times. It was urged that the red lateritic zone represents basalt altered *in situ*, and is clearly connected with the climatic conditions of Eocene times. The pale bauxites are considered to be derived from sporadic eruptions of rhyolite, and a thin bauxite layer overlying the pisolitic iron-ore may in part be formed by wind-borne material.

Messrs. R. J. Ussher, H. J. Seymour, E. T. Newton, and R. F. Scharff gave the results of their joint work in the exploration of the Cave of Castlepook, near Doneraile. Both the geological evidence and the characteristics of the fauna collected lead towards the conclusion that the cave is pre-Glacial in age, and support the opinion that Ireland has not been joined to England by land in Glacial or post-Glacial times.

Messrs. H. B. Muff and R. Carruthers described the structure of the Leenane district, co. Galway, and Prof. S. H. Reynolds and Mr. C. I. Gardiner dealt with rocks along the same strike in the Tourmakeady district, co. Mayo.

The veteran geologist Mr. G. H. Kinahan, although prevented from attending the meeting through illness, sent a paper on the raised beaches of the Liffey Valley, and Mr. H. Bolton reported the details of a boring in the Lower Coal-measures at the Emerald Pit, Dungannon.

The igneous rocks of the seldom visited outer Blasket Islands were described by the president.

Besides the above papers dealing with Irish geology, a fine collection of photographs of geological interest, and a typical set of Irish rocks, were exhibited by Mr. R. Welch and other local workers.

Desert phenomena, which have played so important a part in the proceedings of the section for some years past, were again discussed in several important papers. Dr. W. F. Hume contributed notes on the petrography of Egypt, Mr. G. W. Grabham dealt with the well-water supply of the north-east Sudan, Dr. A. Hutchinson gave the results of a chemical and physical examination of some remarkable crystals of dolomite obtained from Algeria, while fossil deserts were referred to in the report of the Trias Committee. With the view of obtaining further data regarding the conditions under which the Triassic rocks of Britain were laid down, a new research committee was appointed to conduct investigations in the marginal parts of the Sahara about Biskra, in Algeria, and Mr. J. Lomas will shortly proceed to Africa to make observations bearing on the point.

In glacial geology two papers were presented. Dr. Dwerryhouse, in reading the report of the Erratic Blocks Committee, showed that there is still much useful work to be done, despite the long time the committee has been at work. Prof. W. M. Davis, of Harvard University, in dealing with the glacial erosion in north Wales, confined his remarks to the Snowdonian district. He demonstrated that in Tertiary time the mountains existed as a group of monadnocks surmounting a peneplain which extended far into mid-Wales. During the Glacial epoch the intervening valleys were deepened, and cwms were formed which showed that glacial erosion in certain valleys amounted to 400, 600, or 800 feet.

In mineralogy and petrography eight important papers were read. The president, in the course of an examination of the Deccan basalt, found them to contain native iron and gold. Dr. A. Hutchinson described a new method of drawing stereographic projections of crystals, and exhibited a protractor designed for the use of students of crystallography. Dr. H. A. Bemrose showed and described a number of slides illustrating the microstructure of Derbyshire limestones, and Mr. H. Brodrick contributed a note on the structure and occurrence of cave pearls. Dr. Tempest Anderson's paper on the changes in the Soufrière of St. Vincent was a continuation of the work done by Dr. Flett and himself on the remarkable volcanic eruptions which occurred in the West Indies a few years ago.

Dr. J. Milne, in discoursing on the duration and direction of large earthquakes, showed that while small earthquakes have a duration of a few seconds near their origin, and at a distance of fifty to 100 miles they may not be recordable, large earthquakes suffer no appreciable decay during transmission, and their duration appears to increase rather than decrease. Another observation in connection with recent seismological observations is that large earthquakes travel farthest in particular directions.

Other papers on earth movements were contributed by Prof. W. H. Hobbs and Dr. Woolacott. The former dealt with the recent earth movements within the basin of the Laurentian lakes, and by methods of precise levelling he was able to demonstrate that the recent tilting of the province proceeded at variable rates at different points.

Dr. Woolacott, in describing a case of thrust and crush brecciation in the magnesian limestone of Durham, showed that the beds have been thrust against a horst, the flexible beds have been deformed without being much broken, while the harder, brittle limestone has been highly brecciated. He estimates that the amount of lateral displacement has been about 100 yards, and by experimental tests he indicates the magnitude of the thrust to have been about 300 tons per square foot.

The president, in opening a discussion on mountain building, referred to recent investigations on mountain structure, which revealed the fact that in the overlap of recumbent folds the uppermost folds were of greater span than those beneath, and this could not be explained on the notion that horsts of the accepted type were responsible for the features observed. He calculated that at the depth at which the horsts were supposed to exist the rocks would be in a viscous condition owing to radio-active heating and incapable of transmitting a direct thrust. With rigid rocks overlying a viscous mass he showed that compressive forces would cause the rocks to bulge upwards, and lying folds would be produced. Sir Archibald Geikie described the two-fold types of mountains, one possessing the Alpine structure and the other taking the form of plateaux upraised without disturbance except at their margins. He could not accept the explanation offered by Suess for the latter type, that the sea had fallen. He reminded the audience that folding was not all of one age, and the forces which have produced the Alps in the past may be acting at the present day.

Prof. Lapworth, in describing the principal mountain ranges on the earth's surface, urged that in their distribution they follow the curves of harmonic motion. Those existing beneath the ocean or as festoons of islands fall in with the general scheme as illustrated by the law of curves. All the islands of the world and all the mountains are strung on a great circle which corresponds with the line dividing the land and water hemispheres. The northern and eastern hemispheres are above the node of the great curve, while the southern and western hemispheres are below the node. On the great master folds there are smaller corrugations bearing the same relations as the harmonics to the fundamental in a vibrating cord. In this way the central depressions of continents can be correlated with the submerged ridges in the ocean depths.

Prof. Sollas, in referring to the theory put forward by the president, showed that piled-up folds would blanket the deep-seated rocks, and a highly heated region beneath mountain folds might account for the lower value of gravity observed in the neighbourhood of mountain chains. The approximation of remote areas brought about by folding involved the transference of viscous material from one region to another. This would not only result in bulging up, but in the lateral traverse of material. The thrusting which built up the Alps and the Carpathians was felt in the British Islands, and the cracks produced in the splintered crust of Scotland and the north of England might have afforded a passage for the underlying lava, which perhaps originated under the Alps. Given the deformational figure of the earth, the position of mountain chains follows from it, since on Prof. Joly's theory they will arise where sedimentation has taken place, *i.e.* at the limit of land and water.

Prof. Cole suggested that the older opinion of Scrope regarding uplift and sliding was receiving confirmation in later days, and the festoon arrangement of islands and mountain chains was the result of the frontal movements of sliding masses.

Palæontology was represented in the section by papers dealing mainly with the fossil Reptilia. Prof. H. G. Seeley described a fossil reptile from the Upper Karroo of Cape Colony which possessed a proboscis or trunk, and in a second paper the dentitions of the Cynodontia and Gomphodontia were contrasted.

The occurrence of reptilian footprints in the Inferior Oolite of Whitby was announced by Mr. H. Brodrick, and in the Trias report Mr. H. C. Beasley described the tracks of invertebrates found in association with footprints in the Triassic rocks.

Mr. W. Whitaker, in describing a deep boring recently made on the Thames marshes at Cliffe, reported a fact which has an important bearing on the character of the floor of older rocks underlying the Secondary rocks of Kent. At 1030 feet below Ordnance Datum Silurian rocks were penetrated. The practical bearing of the boring is that it puts a northern limit to the Kent coalfield.

## *PHYSIOLOGY AT THE BRITISH ASSOCIATION.*

THE large number of individual papers presented this year made it necessary to hold afternoon sessions each day of the meeting, and even then it was difficult to find room for all the papers. Apart from the president's address, which has been published already (October 1, p. 553), the various communications are described herein, but owing to lack of space some of the papers, which cannot be conveniently summarised, are noted only by title.

After the presidential address, Prof. Sherrington, F.R.S., read a paper on proprioceptive reflexes of the limb. In a decerebrate animal the two hind legs are prepared so that all the muscles, except the extensor of each knee, are paralysed. Thus there is left on each side an afferent and an efferent nerve supply from a single muscle. The limbs are supported so that the knee can be extended by muscular contraction and flexed by gravity. Flexion at the right knee causes extension of the left leg, whilst extension on the right causes flexion on the left; that is, stretching the extensors causes a reflex contraction of the crossed extensors, and relaxation of the extensors produces reflex inhibition of the crossed extensors. The tone of the muscle depends on reflex impulses from itself, and when the extensor is passively stretched it does not return to its original length, but, being inhibited, remains more flexed than it had been; conversely, relaxation of the extensors leaves the limb in a more extended position. The final report of the committee on the "metabolic balance sheet" of the individual tissues was presented by Prof. Gotch, F.R.S. The object of the committee, namely, the development of sound and fruitful methods for investigating the metabolism of individual tissues, having been accomplished, it did not desire re-appointment. The report reviews the work that has been done by the committee during the past five years. The technique of various experimental procedures has been improved upon, and these improvements are dealt with as follows:—gas analysis, anæsthetics, prevention of clotting, measurement of rate of flow, and analysis of gases of perfusion fluids. The organs employed and a comparison of the results obtained are stated, and the report concludes with a list of the papers so far published as a result of the work of the committee. Sir Lauder Brunton, F.R.S., whilst presenting the report of the committee on the effect of climate on health and disease, read a paper on influenza, showing that epidemics of influenza are accompanied by an increased death-rate from pulmonary diseases, and he compared these outbreaks with various meteorological data. Dr. Grabham then gave a paper on the physics of high altitudes in relation to climate and health. From various measurements of humidity, wind pressure, and electrical potential he suggests that deficient electrical charge in the atmosphere is one of the conditions in a relaxing climate.

In the afternoon Prof. Swale Vincent presented the report of the committee on ductless glands. The view that the thyroid and parathyroids are intimately related is supported, and evidence is furnished that the suprarenal gland constantly pours its secretion into the blood stream, and thus regulates the blood pressure. Prof. Macallum, F.R.S., read two papers. In the first he recorded the analysis of urine in polyuria produced by the ingestion of large quantities of water. The total solids were so reduced that freezing-point determinations showed a very much reduced lowering. The percentage of chlorides decreased from the onset of polyuria, whilst that of potassium did not diminish until later on; thus at first the potassium showed a marked rise relatively to the sodium; at the same time, he could not find any appreciable dilution of the blood. These experiments are contrary to the view that urine is merely filtered from the blood, but they suggest that there is a selective action of the epithelial cells. His second paper dealt with the distribution of potassium salts in the cell, and he ascribed their localised situation to surface-tension effects. Prof. MacDonald considered that these local appearances were explained by these points being stimulated portions of the protoplasm. Dr. Hewitt read a paper advocating improvement in the training of anæsthesists. He pointed out that the number of deaths from anæsthesia is increasing, and recommended that all medical students should be taught, by a qualified instructor, the best method of administering anæsthetics. Prof. Waller, F.R.S., demonstrated tracings obtained from muscles immersed in saline containing varying percentages of chloroform, ether, or alcohol. The relative toxicity of these drugs is that 1 molecule of chloroform = 12 molecules of ether = 100 molecules of alcohol.

On the Friday morning the first item was a discussion on mental and muscular fatigue, introduced by Dr. W. McDougall. He stated that fatigue is the change in ratio of two variable factors, one of which is the amount of available energy and the other the resistance which has to be overcome. As the resistance rises it is more difficult to do work until a point is reached where fatigue is manifested. This fatigue can be overcome by some more stimulating occupation, but in the end the subject is left more fatigued. He also discussed the effect of waste products and the removal of reserve food material on the activity of the cells. The resistance, which he supposed to take place at the synapse, is protective, as it prevents too great a drain of energy by continued action. Rise of resistance in one path diverts the impulse into another path, and this is exemplified by the difficulty of maintaining the attention on any one detail, as fatigue is delayed by minute variations in the object of attention. He then illustrated various nervous disorders as depending on the ratio of resistance to energy. Prof. MacDonald treated the subject of muscular fatigue, pointing out the change in distribution of salts and water during muscular contraction. Potassium salts are liberated in the central portion of the sarcomeres, thus causing a rise in osmotic pressure, and this attracts water from the neighbouring portions of the muscle fibre, causing this portion of the sarcomere to swell laterally. The contraction is the result of the shortening due to transference of water from the longitudinal to the transverse axis of the muscle. Prof. Milroy spoke about fatigue of colour sensations in simultaneous contrast. Mr. Sackville Lawson gave some measurements of skin sensation by the æsthesiometer, showing that mental fatigue diminishes the acuity of touch sensations. Several others took part in the discussion. Prof. Elliot Smith, F.R.S., then gave two communications. The first, in conjunction with Prof. Wilson, described the results of electrical stimulation of the cerebral cortex of certain lemurs. The second presented a map of the brain showing different areas which correspond to different naked-eye appearances of sections made transversely to the cortex.

During the afternoon session the following papers were read:—Prof. Gotch, F.R.S., showed tracings of photo-electric changes in the eye on exposure to light. The fundamental change is a prolonged electric current due to changes in the visual purple, because this current does not appear after the visual purple has been bleached. At the moments of exposure and cutting off of light there are more intense currents which are only of short duration, but they occur even after bleaching of the visual purple. These two rises are mounted on the more prolonged rise due to the visual purple. Repeated illumination causes the appearance of a precursor to the sudden rise due to illumination, and this precursor is a current in the reverse direction to the other currents. All colours of light can bleach the visual purple. Dr. Edridge-Green described methods for testing colour-blindness, and demonstrated apparatus for performing the various tests. Prof. Waller, F.R.S., presented the report of the committee on the electrical phenomena and metabolism of arum spadices. Dr. MacLean described experiments showing that all the nitrogen in lecithin is not present as choline, and Sir James Grant read a paper on the gastro-intestinal ganglionic nervous system.

Monday morning was commenced by a discussion on instruction of school teachers in physiology and hygiene, introduced by Prof. Sherrington, F.R.S. He pointed out that school teachers, having the charge of so many children, should know how to take care of their health and be able to detect certain departures from the normal. Physiology is the basis of hygiene, and if physiology is known hygiene follows as a practical and common-sense application of its laws. Psychology is also important, as it gives the teacher an insight into the minds of his pupils; but here again physiology should be known first. The subject should not be taught by books alone, but by demonstrations and practical work, as that is the only way really to appreciate any science. Prof. Thompson detailed the steps that had been taken to teach physiology to school teachers in Ireland. Prof. Gotch, F.R.S., said that the teacher should learn physiology to apply it, but not to teach it. Any instruction to the children should be by example and not by precept. Dr. McVittie gave instances of the effect of neglect of hygiene in schools. Other speakers emphasised the importance of teaching physiology to school teachers in order that the general public might have a more enlightened view of hygiene, especially personal hygiene. Prof. Sherrington then presented the report on the conditions of health essential to the carrying on of the work of instruction in schools (prepared for Section L). After the closing of the discussion Prof. A. Kossel (Heidelberg) read a paper on amyloid, identifying the various radicals which enter into its constitution. Dr. Cathcart described experiments showing that various substances introduced into the pyloric portion of the stomach cause secretion in the fundus. Tap-water, although causing energetic movements of the pyloric segment, was about the only substance which did not cause secretion. It was not definitely determined whether the secretion is due to chemical or nervous stimulation. Dr. Ellison showed records illustrating the effect of intravenous injection of a substance isolated from commercial peptone. Dr. Dawson Turner read a paper on the hæmo-renal index, and demonstrated growth by osmosis after the method of Prof. Leduc.

At the afternoon meeting Dr. Copeman, F.R.S., presented the report of the committee on body metabolism in cancer. Dr. Page May gave lantern demonstrations showing (*a*) a hitherto undescribed (postero-septal) tract in the spinal cord, and (*b*) cells and tracts concerned in paralysis and recovery from paralysis. Mr. Walker read a paper describing the effect of two antisera prepared in rats by injecting in one case extract of testes and in the other carcinoma cells from an experimental tumour. These antisera, injected into mice infected with the same strain of experimental tumour used in preparing the second antiserum, appeared to interfere with the development of the growth. Prof. McWeeney described the technique used by him in carrying out the biological method of identifying blood stains, and he also testified to its value from a medico-legal standpoint. Prof. B. Moore read a paper, for himself and Dr. Roaf, on the action of acid and alkali on the growth and division of animal and vegetable cells. The sitting was terminated by a lantern demonstration, by Dr. Herring, of the changes in the pituitary after thyroidectomy. Removal of the thyroid causes a colloid-like substance to be formed in the pituitary, and this substance passes through into the third ventricle, thus reaching the cerebro-spinal fluid.

On Tuesday morning a joint meeting with Section D was held. Most of the papers are noted under the proceedings of that section, but the two following papers are of physiological interest. Dr. Nierenstein described experiments showing that atoxyl combines with proteins, but the diacetyl compound does not. *In vivo* the acetyl compound is hydrolysed, and acts like atoxyl. He compared the pharmacological action to the chemical process of dyeing, where the chromophore is represented by the arsenic and the chromogen by the amido-group in atoxyl, and the mordant is replaced by protein. Prof. B. Moore described the effect of many substances upon experimental trypanosomiasis. The combined treatment, using atoxyl followed by mercury, is the best, and the only other metal that can compare in action with arsenic is antimony.

The section closed by a meeting on Tuesday afternoon, with Lord Aberdeen in the chair. Sir Robert Matheson read a paper on the anti-tuberculosis campaign in Ireland.

H. E. Roaf.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

CAMBRIDGE.—At Emmanuel College, the exhibition of 50*l.*, tenable for two years, offered to an advanced student commencing residence this October, has been awarded to L. J. Russell, Glasgow University. Other exhibitions of 30*l.*, tenable for two years, have been awarded to W. T. Gordon, Edinburgh University, and to A. Ll. Hughes, Liverpool University.

OXFORD.—The jubilee of the inception of the University museum is to be commemorated to-day, October 8, by a meeting in the Sheldonian Theatre and a conversazione at the museum. A distinguished company has accepted invitations to be present. The foundation-stone of the building was laid on June 20, 1855, and the work was completed in October, 1858. Its erection represents the result of a movement for the provision of "an edifice within the precincts of the University for the better display of material illustrative of the facts and laws of the natural world." One of the aims of the promoters of the scheme was to gather together various branches of sciences "for mutual aid, and easy interchange of reference and comparison." The museum has thus connected with it departments of medicine and public health, comparative anatomy, physiology, human anatomy, zoology, experimental philosophy, physics, chemistry, geology, mineralogy, ethnography, and pathology. Teaching began in two departments fifty years ago, and the present museum represents the outcome of that beginning.

In connection with the celebration of the jubilee honorary degrees are to be conferred upon Prof. Arrhenius and Dr. A. G. Vernon Harcourt, F.R.S. At the reception in the afternoon Dr. Harcourt will give a short account of the establishment and work of the museum, and a bust of Prof. W. F. R. Weldon, who died in 1906, will be unveiled.

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MR. JACOB SASSOON has given ten lakhs of rupees (66,000*l.*) to establish a central college of science in Bombay.

THE Salters' Company has voted 100*l.* per annum for a period of three years to the cancer research laboratories of the Middlesex Hospital as a research scholarship.

THE distribution of prizes, diplomas, &c., at the South-Eastern Agricultural College, Wye, will be made on October 21, when Sir Horace Plunkett, F.R.S., will deliver the inaugural address.

THE Pereira medal of the Pharmaceutical Society, awarded annually for high proficiency in *materia medica*, botany, and chemistry, was presented to Miss Gertrude H. Wren on September 30, this being the first occasion upon which the prize was received by a woman.

THE Child Study Society of London will resume its meetings for lectures and discussions on October 15, at 8 p.m., in the Parkes Museum, Margaret Street, London, W. At the opening meeting Dr. C. W. Kimmins will deliver an address on the relation of the curriculum to the development of the child. At subsequent meetings Miss Alice Ravenhill will describe some results of an investigation into hours of sleep among English elementary-school children; Dr. G. Eric Pritchard will lecture on the physiology of the child; Dr. F. H. Hayward will deal with education and recent studies in heredity; and Dr. James Kerr will take for his subject the educational revolution and some hints for the future.

THE Board of Education has issued the following list of successful candidates for Royal exhibitions, national scholarships, and free studentships (science), 1908:—*Royal Exhibitions:* A. Riddle, Portsmouth; T. J. Hornblower, Southsea; A. H. Gabb, Swindon; A. E. Stone, Portsmouth; F. Morris, Portsmouth; S. B. Hamilton, Halifax; A. H. Barrett, Southsea. *National Scholarships for Mechanics (Group A):* B. C. Carter, Southsea; A. J. White, Southsea; H. H. German, Devonport; W. F. Boryer, Portsmouth; H. Mawson, Hunslet, Leeds. *Free Studentships for Mechanics (Group A):* G. W. Bird, Plymouth; H. G. Stephens, Leicester. *National Scholarships for Physics (Group B):* J. Lamb, Gateshead; H. Billett, Swindon; F. C. Hobbs, Bristol; R. Ecker, Norwich; T. W. Johnstone, Neyland, Pembrokeshire. *Free Studentships for Physics (Group B):* P. H. S. Kempton, Swindon; W. Jevons, Smethwick. *National Scholarships for Chemistry (Group C):* W. A. C. Newman, Leeds; E. W. Yeoman, Southampton; F. Hargreaves, Burnley; L. D. Goldsmith, London; E. Jobling, Hull; E. O. Jones, Leeds. *Free Studentship for Chemistry (Group C):* L. Owen, Trefriw, Carnarvonshire. *National Scholarships for Biology (Group D):* E. Hill, Bradford; H. Wormald, Wakefield; T. E. Herbert, London. *Free Studentship for Biology (Group D):* E. T. Halnan, London. *National Scholarships for Geology (Group E):* H. Hart, Camborne; A. Sharples, Burnley; J. W. Chaloner, Burnley.

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## *SOCIETIES AND ACADEMIES.*

### LONDON.

**Royal Society**, Received July 31.—"On Helium in Saline Minerals, and its Probable Connection with Potassium." By the Hon. R. J. **Strutt**, F.R.S.

In a former paper (Roy. Soc. Proc., A, vol. lxxx., p. 592) the author mentioned that saline minerals were often comparatively free from contamination with radio-active material of the uranium-radium series. Accordingly, they afford special opportunities of testing whether or not helium is generated by the other elements present, namely, sodium, potassium, magnesium, calcium, sulphur, chlorine, oxygen, hydrogen. In this paper determinations are given of helium and radium in some of the saline minerals of Stassfurt.

Helium was liberated by solution of the mineral in water, and was suitably purified. Uranium was determined in the same solution, by the usual method of boiling out the radium emanation generated in a definite period.

The results were as follows:—

| Mineral | Composition | Helium, c.mm. per 100 grs. | Grams uranium oxide ($U_3O_8$) per 100 grs. | Helium, c.c. per gr. $U_3O_8$ |
|---|---|---|---|---|
| Rock salt . | $NaCl$ | 0·0233 | $7\ 1 \times 10^{-6}$ | 3·3 |
| Sylvine . . | $KCl$ | 0·55 | $2·15 \times 10^{-6}$ | 256 |
| Carnallite . | $KMgCl_36H_2O$ | 0·151 | $3·23 \times 10^{-6}$ | 47 |
| Kieserite . | $MgSO_4H_2O$ | 0·0179 | $6·47 \times 10^{-5}$ | 0·277 |

Some other salts were also examined qualitatively.

In none of them was the quantity of helium at all comparable with what was observed in carnallite or sylvine, though $D_3$ could generally be seen.

Returning to the quantitative experiments, it is noticeable that very high ratios of helium to uranium oxide are met with in these two minerals.

It seems altogether improbable that the minute traces of uranium and radium present can account for so much helium. On the other hand, the helium in rock salt is very much of the order to be expected from its geological age if it originates from the uranium family of radio-active bodies.

In view of Campbell and Wood's observations on the radio-activity of potassium (Camb. Phil. Soc. Proc., vol. xix., p. 15), the author is disposed to regard that element as the source.

Received July 28.—"On the Accumulation of Helium in Geological Time." By the Hon. R. J. **Strutt**, F.R.S.

In a former paper (Roy. Soc. Proc., A, vol. lxxx., 1908, p. 572) the author gave an account of experiments on the presence of helium in a variety of the common minerals of the earth's crust. The conclusion arrived at was that the quantity of helium is, in general, determined by the traces of radio-active elements present. The minerals investigated were mostly of Palæozoic age, and little attention was paid to the effect of geological age on helium content. If, however, the accepted theory of the progressive accumulation of helium in minerals by radio-active change is correct, it is evident that geological age must be all-important. In the present paper the subject is considered from that point of view.

There is some difficulty in finding suitable material for comparing the helium content of minerals with their geological age. The author has been fortunate in discovering that phosphatic nodules (the so-called coprolites) and phosphatised bones are extremely rich in radio-active constituents, sometimes containing fifty times as much radium as the generality of rocks. These nodules and bones are found in a great variety of strata, from the Pliocene downwards. The nodules frequently contain, or consist of, fossils characteristic of the stratum to which they belong, or of one very little earlier; thus their age is well defined. The same remark applies still more to the mineralised bones. There is no reason to doubt that the radio-active material was introduced into the bones by infiltration at the time that they became phosphatised, and from that epoch the accumulation of helium must be dated.

In these experiments the author has extracted the helium by solution of the powdered substance in hydrochloric acid. The action takes place quite readily.

Radium was determined by the methods described in earlier papers. The solution obtained in extracting helium was usually employed for the radium determination.

The uranium oxide percentage was calculated from the radium observations by standardisation with a uranium mineral.

The results may be tabulated as follows:—

his latest estimate. It is that 316 cubic mm. of helium are produced per gram of radium per annum. This is deduced on the following assumptions:—

(1) The number of helium atoms produced is equal to the number of $\alpha$ particles emitted.

(2) For every four $\alpha$ particles emitted by radium with its immediate products, two are emitted by uranium, one by ionium, and one by polonium.

The author does not enter on any discussion of the validity of these suppositions, beyond remarking that there are no definite grounds at present for deciding whether or not helium is liberated in the rayless changes.

Taking the ratio of radium to uranium in minerals as $3{\cdot}4 \times 10^{-7}$, we get for the annual helium production per gram of uranium oxide, ($U_3O_8$) in a mineral, $9{\cdot}13 \times 10^{-8}$ c.c.

Adopting this rate of growth provisionally, the following ages are obtained *as a minimum* for some of the materials examined:—

| | Years |
|---|---|
| Phosphatic nodules of the Crag ... ... | 225,000 |
| Phosphatic nodules of the Upper Greensand... | 3,080,000 |
| Phosphatic nodules of the Lower Greensand... | 3,950,000 |
| Hæmatite overlying Carboniferous Limestone | 141,000,000 |

It must be emphasised that these absolute values are provisional only. It is hoped that geologists and others will not regard the method as discredited if it should be necessary to alter them considerably, when the rate of growth of helium has been directly determined.

| Material | Locality | Geological Horizon | Helium, c.mm. per 100 grams | $U_3O_8$, grams per 100 grams | Helium, c.c. per gram of $U_3O_8$ |
|---|---|---|---|---|---|
| Phosphatised shark's teeth .. | Florida ... ... ... ... | Pliocene ... ... ... ... | 0·174 | $2{\cdot}48 \times 10^{-2}$ | 0·0070 |
| Phosphatised Cetacean bones ... | Felixstowe ... ... ... ... | Pliocene Red Crag ... ... | 0·158 | $1{\cdot}55 \times 10^{-2}$ | 0·0102 |
| Phosphatic nodules ... ... ... | ,, ... ... ... ... | ,, ,, ,, ... ... | 0·098 | $4{\cdot}78 \times 10^{-3}$ | 0·0205 |
| ,, ,, ... ... ... | Cambridge ... ... ... ... | Upper Greensand ... ... | 3·03 | $1{\cdot}08 \times 10^{-2}$ | 0·281 |
| ,, ,, ... ... ... | Potton, Bedfordshire ... | Lower Greensand ... ... | 2·10 | $5{\cdot}83 \times 10^{-3}$ | 0·360 |
| Phosphatised Saurian bones ... | Ely ... ... ... ... ... | Kimmeridge Clay ... ... | <0·365 | $3{\cdot}28 \times 10^{-3}$ | <0·111 |
| Phosphatic nodules ... ... ... | Knapwell, Cambs. ... ... | Base of Kimmeridge Clay . | <0·675 | $7{\cdot}20 \times 10^{-3}$ | <0·094 |
| Phosphatised Saurian bones ... | Whittlesea ... ... ... ... | Oxford Clay ... ... ... | <0·51 | $9{\cdot}15 \times 10^{-4}$ | <0·558 |
| Phosphatic bone fragments ... | Lyme Regis ... ... ... | Rhætic bone bed ... ... | <0·22 | $2{\cdot}15 \times 10^{-3}$ | <0·102 |
| Hæmatite ... ... ... ... ... | Frizington, by Carnforth, Cumberland ... ... ... | Above Carboniferous Limestone ... ... ... ... | 16·5 | $1{\cdot}28 \times 10^{-3}$ | 12·9 |
| Phosphatic nodules ... ... ... | Near Bala ... ... ... .. | Bala beds .. ... ... ... | 15·3 | $3{\cdot}23 \times 10^{-3}$ | 4·74 |
| Phosphatic limestone ... ... | Chirbury, Shropshire ... | Llandeilo Limestone .. ... | 5·6 | $7{\cdot}90 \times 10^{-4}$ | 7·10 |
| Phosphatic nodules ... ... ... | Cailleach Head, Loch Broom | Torridon Sandstone ... ... | 0·83 | $9{\cdot}9 \times 10^{-4}$ | 0·84 |

It will be at once noticed that the order of stratigraphical position is not accurately followed. For example, the phosphatic nodules and bones from the Kimmeridge Clay do not show so high a helium ratio as those from the Lower or Upper Greensand, though they are geologically older than either. At the same time it will be noticed that helium ratios approaching 12, such as are common in the mineral veins of Carboniferous age in Cornwall, are not met with in the younger strata.[1] The facts are most easily explained by supposing that the retention of helium has been often, if not always, imperfect.

One point remains to be referred to. If thorium were present in any of these materials we might expect it to have a disturbing influence, as an independent source of helium. The most searching experiments the author has been able to make have only suggested a faint suspicion of its presence in the phosphatic nodules and bones. It can contribute nothing appreciable to their activity. The same applies to Cumberland hæmatite; in this case the results were still more distinctly negative.

The chief interest of the present results is in their application to the measurement of geological time. For this application we require to know the rate at which helium is produced from 1 gram of uranium with the equilibrium quantity of all the other products of the series.

Prof. Rutherford has kindly communicated to the author

[1] Examples will be found in Roy. Soc. Proc., A, vol. lxxx., p. 573. The values are not reprinted here, as they were only obtained by the crude method of heating the minerals. This, however, suffices to give the order of magnitude.

The conclusions of this paper may be summarised as follows:—

(1) Phosphatic nodules and phosphatised bones of all geological ages possess marked radio-activity, many times higher than that of rocks. This activity is due to products of the uranium series.

(2) Helium has been detected in these materials, even when they are not of more than Pliocene age.

(3) The ratio of helium to uranium oxide has been measured. This ratio does not strictly follow the order of superposition of the strata; but high ratios are not met with in the younger deposits, whereas they are common in the older ones. It is conjectured that helium has been imperfectly retained, at all events in some cases.

(4) Provisional values are given for the time required to accumulate the quantity of helium now found in the nodules and other materials.

PARIS.

**Academy of Sciences**, September 28.—M. Bouchard in the chair.—Two applications of Fredholm's equation to some problems of mathematical physics: Émile **Picard**. When a problem has been reduced to this equation it is usually sufficient to examine whether this is a singular case or not. In certain circumstances more complex conditions may arise; two simple examples of such cases are discussed in the present paper.—Experimental parthenogenesis by electrical charges: Yves **Delage**. The eggs are placed in a vessel the base of which forms one plate of an electrical condenser, and submitted to a series of charges. Blank experiments with the electrolytic solution used proved conclusively that the latter alone, without the electric stimulation, could not cause the development of the eggs. With the electric charges the eggs developed to the larval stage. The possible causes of this action are discussed, and further experiments promised as regards the effect of the sign of the charge, the voltage, time of application, temperature, &c.—The relative stability of the polycarbonic cyclic groups: Louis **Henry**. In a previous paper the effect of dehydrating dimethyl-isopropyl-carbinol, $(CH_3)_2.C(OH).CH(CH_3)_2$, has been shown to give rise to two isomeric unsaturated hydrocarbons, tetramethylethylene and methyl-isopropylethylene. The dehydration of the closely related cyclic compound, dimethyl-cyclopropylcarbinol, $\begin{matrix} CH_2 \\ | \\ CH_2 \end{matrix} \!\!>\! CH : C(OH)(CH_3)_2$ has now been studied. Acetic anhydride, which readily dehydrates the open-chain compound, transforms the cyclic compound into an acetate, no ethylene hydrocarbons being formed. It is necessary to use a more energetic dehydrating agent, phosphorus pentoxide, to produce the latter action. The action of potassium acetate upon the corresponding bromide gives the acetate instead of ethylene hydrocarbons, as with the open-chain compounds, the trimethylene derivative throughout showing the greater stability.—Systems of families of surfaces cutting along conjugated lines: S. **Carrus**.—Certain properties of curved surfaces: A. **Demoulin**.—The sixth geodetic campaign in the higher regions of the French Alps: Paul **Helbronner**. The atmospheric conditions were not so favourable as in the preceding year, but the remaining six points out of the thirty-two originally planned were determined. The second part of the work comprised the preparations for the triangulation in detail of Haute-Maurienne.—Wehnelt's interrupter: Paul **Bary**. The author develops a theory of the action of the Wehnelt contact breaker based on the production and condensation of vapours in narrow tubes under the action of the current. According to this view the action is not dependent on electrolytic action, but is rather analogous to a hydraulic ram or a pulsometer. The theory gives a good account of the experimental results.—The effects of *Oïdium quercinum* on different species of oaks: Ed. **Bureau**. The species are classified in three groups, those the leaves of which are refractory to the disease, those the younger leaves of which only are attacked, and those all of the leaves of which are attacked.—A seismograph registering electrically at a distance: B. **Galitzine**.

NEW SOUTH WALES.

**Royal Society**, August 5.—Mr. W. M. Hamlet, president, in the chair.—The pines of Australia, part i.: R. T. **Baker** and H. G. **Smith**. The Australian pines, Callitris, form a distinguishing feature of the landscape in various parts of the continent. In order to investigate their commercial possibilities, a research has been in progress now for some years at the museum, and during this period a very large amount of useful data has been accumulated which it is proposed to publish from time to time. In it is given a full account of the botany and chemistry of the "white or cypress pine," *Callitris glauca*, a species that has the largest geographical range of the genus, occurring in nearly all the States of Australia.—Contributions to the flora of Australia: Dr. A. J. **Ewart** and Miss Jean **White**, assisted by J. R. **Tovey**. The paper contains descriptions of new species and new varieties. It contains also some critical notes on rare and otherwise interesting plants, chiefly from Western Australia, and concludes with some records of introduced plants, together with notes on erroneous records of naturalised aliens.

**Linnean Society**, July 29.—Mr. J. H. Maiden, vice-president, in the chair.—The genus Nannodythemis (Neuroptera: Odonata), with descriptions of new species: R. J. **Tillyard**. The type of this aberrant genus is *Nannodythemis australis*, Brauer. Two closely allied species, described in this paper, have now been discovered, one from West Australia and the other from the Blue Mountains.—Studies on Australian mollusca, part x.: C. **Hedley**. A series of co-types of rare and unfigured Australian shells was lent to the writer by the British Museum. With their help many difficult points in synonymy are now elucidated, and drawings are presented of a dozen hitherto unfigured shells, inadequate descriptions of which have troubled systematists for more than half a century.—The acidity of milk: Dr. H. G. **Chapman**. The acidity of milk determined within one minute of milking varies from 12° to 19°. The rate at which the acidity increases in milk upon standing was determined. For ten hours there is no increase. The acidity of many samples bought in Sydney was found to be between 12° and 20°. This acidity is not due to lactic acid, but to acid phosphate and dicaseinate.

August 29.—Mr. A. H. S. Lucas, president, in the chair.—Some Sydney desmids: G. I. **Playfair**.—The distribution, origin, and relationships of alkaline rocks: Dr. H. I. **Jensen**.—The alkaline petrographical province of eastern Australia: Dr. H. I. **Jensen**.

## CONTENTS.

THURSDAY, OCTOBER 15, 1908.

## AIDS TO MATHEMATICAL RESEARCH.

*Royal Society of London, Catalogue of Scientific Papers*, 1800–1900. Subject Index Vol. I. Pure Mathematics. Pp. lviii + 666. (Cambridge: University Press, 1908.) Price 21*s*. net.

THE output of the scientific world is now so great that considerable attention has been devoted of late to devising means of acquainting those engaged in scientific research with the results attained by other investigators. With the publication of the first volume of the Royal Society Index, the student of mathematics is now particularly well provided in this respect. No one work could provide for his needs, and in fact they are at present supplied by several publications. The helps which have been provided for him naturally fall into three groups. The first of his needs is a means of obtaining a rapid survey of any department of his subject which will make him acquainted with the principal writings on it. Numerous encyclopædic works have been published which aim at supplying this want, the most important being the "Encyklopädie der mathematischen Wissenschaften," which is at present in course of publication. A more important need is a means of following the course of current publications without an impracticable amount of reference to the papers themselves. This want is admirably supplied by the "Jahrbuch über die Fortschritte der Mathematik." This valuable work, which appeared first in 1871, gives abstracts of all papers dealing with mathematics which have appeared within a space of twelve months, but it does not appear until two years after the one with which it deals. The abstracts in this work are arranged by subjects and indexed under the authors' names.

Even the comparatively short delay in the publication of the "Jahrbuch" was found inconvenient, so in 1893 the Mathematical Society of Amsterdam arranged to publish the "Revue Semestrielle," a half-yearly list of papers, arranged according to periodicals, giving titles and a short indication of the subject-matter. Each paper is classified in accordance with an international code, and a subject-index is given as well as an authors' one. In addition to these, the "International Catalogue of Scientific Literature" has appeared annually since 1902, one volume being devoted to mathematics. In this work the papers of the previous year are arranged according to subjects, an index of authors' names being appended.

The above works are supplemented by two immense publications, Poggendorff's "Handwörterbuch zur Geschichte der exacten Wissenschaften," and the Royal Society's "Catalogue of Scientific Papers." The former, which consists of four volumes, gives the works of authors up to 1904, and includes physics, astronomy, chemistry and geology, besides mathematics; the latter covers a much larger range of subjects, and extends to twelve large volumes; its scheme is very similar to that of the "Handwörterbuch," but the volumes already published only extend from 1800 to 1883.

These works, though of incalculable value to the investigator, do not directly supply him with information on a given part of his subject, which is of course what he generally requires. Hitherto he has had to rely mainly on his own sagacity and experience, although of late many bibliographies have been published for special subjects. The book under review will materially lessen this part of the student's labour, and is bound to form an essential part of his scientific equipment; all the more so as it is extremely moderate in price, which cannot be said of any of the other works mentioned above with the exception of the "Revue Semestrielle."

When the "Catalogue of Scientific Papers" was projected by the Royal Society in 1857, the plan included a subject-index, and during the compilation of the published twelve volumes much material was amassed for this purpose. Its completion and publication was found, however, to involve more expense than could be met unaided by the Royal Society, and it is only lately that the funds at the disposal of the Royal Society have been so augmented by private donations as to admit of the completion of the work. The preface states that the Index is especially indebted to Dr. Ludwig Mond, F.R.S., in this respect.

The Index, which will include all papers published during the last century, is to appear in seventeen volumes, each of the volumes dealing with one of the sciences of the schedule of the "International Catalogue." The first volume of the series, which is the subject of this review, deals with pure mathematics. In it all papers on this subject published from 1800 to 1900 have been indexed under subjects, with the exception of about 750 short notes dealing principally with elementary geometry, which were not thought of sufficient interest to be entered. Any mathematician will at once recognise what immense labour this must have involved: the preface gives the number of entries as 38,748, referring to 700 serials.

The index of titles from 1884 to 1900 has been made by referees familiar with the subjects, who have made the titles from the contents of the papers and not merely from headings. Papers published prior to 1884 were not in all cases consulted, but a test made in a subject, with the literature of which the writer is familiar, seems to show that the value of the index has not suffered materially from this.

It is manifestly impossible to discuss here such a work as the Index in detail. Its value was therefore tested by comparison with a bibliography dealing with matrices. The comparison emphasised the difficulties of classification which are inherent to a work like this. In fact, papers dealing with the theory of matrices are scattered over some five or six different headings. This is a drawback which could not have been obviated without swelling the volume to an impracticable size by numerous cross-references, and after a little experience it causes less inconvenience than might be supposed. In some cases, however, the classification might have been easily improved upon. For instance, it is curious to find that the principal modern papers on hypercomplex numbers are classified under the heading "Other Special Sorts of Complex Numbers," while the older papers are properly classified under the heading "General." Again, Hamilton groups are classified under "Quaternions," and not as one would expect under "Groups." Occasionally the subdivision of headings is carried so far as to be a hindrance instead of a help. For instance, references to papers on matrical equations are scattered over five separate headings, instead of being under one heading with two or three subheadings. Several short notes also have been omitted which might well have found a place. A short note appearing early in the development of a subject is of more importance than a similar one appearing at a later stage. If it was impracticable to classify all such notes minutely, they might have been given under the main headings without any subclassification.

Another difficulty which is likely to occur now and again in the use of the Index is that occasionally short papers are published for the first time in the collected works of an author. Such papers are not classified in the Index, which only includes periodicals in its list. In the case of matrices, too, several interesting accounts of the subject have appeared as appendices to treatises having no direct connection with this subject except in so far as matrices are required for some portions of the analysis. Such articles are of course not indexed, although they are sometimes of some importance.

Such criticisms of detail might no doubt be carried much farther; they affect, however, only points of comparatively small importance, and do not affect materially the great service which the Index will render to the mathematical public. At a moderate estimate it will lessen the labour of forming bibliographies, or of hunting up references, by considerably more than one-half. An exceedingly useful feature of the work is a list of periodicals which gives the names of the principal British libraries in which they are to be found. This should effect a great saving of time for those who are not so fortunate as to be situated close to any of our principal libraries.

The Index is published by the Cambridge University Press, and, as is usual in books published by them, the printing leaves nothing to be desired.

## MODERN MARINE ENGINEERING.

*Marine Engineering (a Text-Book).* By Engineer-Commander A. E. Tompkins, R.N. Third edition, entirely re-written, revised, and enlarged. Pp. viii +812. (London: Macmillan and Co., Ltd., 1908.) Price 15*s.* net.

MARINE engineering has been developed in many directions during recent years, and the influence of these developments upon the design of steamships has been marked. Within a period of fifteen or sixteen years water-tube boilers have practically taken the place of cylindrical (or "tank") boilers in all classes of warships; steam-turbines have been introduced for ship-propulsion, and have already superseded reciprocating engines in the Royal Navy, while growing in favour in other war-fleets and in mercantile steamships; oil-fuel has been adopted as a supplement to or substitute for coal; and now internal-combustion engines are being introduced and greatly increased in size and power. It is a natural consequence of these changes that numerous additions should be made to the literature of the subject, and that new editions of standard text-books should appear.

Among these text-books, intended primarily for the use of students, the work under review holds a distinguished place. The author is an experienced engineer officer of the Royal Navy, who has served long at sea in charge of machinery, and has also been occupied for some time as instructor and lecturer in marine engineering at the Royal Naval College, Greenwich, and the Royal Naval War College. At both these establishments he had to do chiefly with naval officers, whose technical knowledge of engineering was much the same as that of students beginning work on the subject. He has consequently given explanations of both theory and practice in simple language, which makes the book serviceable, not only to students of marine engineering, but to general readers desirous of obtaining acquaintance with modern methods and the most recent designs of marine engines and boilers. This third edition is virtually a new book—re-written and considerably larger than its predecessors—bringing information up to date. It deals briefly with types of boilers and machinery which have been made obsolescent by the progress of recent years, and aims at the presentation of "a summary of the best practice of the present day." It is but justice to the author to say that this intention has been realised.

The theory of thermodynamics is treated in an elementary manner, and its applications to the formation and expansion of steam are explained. One section is devoted to marine boilers, and the various types of water-tube boilers now in use are fully described. Another section treats of combustion, giving details of the methods adopted for efficiently burning coal and liquid fuel, and particulars of the various kinds of liquid fuel now in use. The conclusions reached by the author are that, for a given weight of coal and oil, oil gives from 25 to 30 per cent. greater energy, reduces the space for stowage by 10 per cent., makes it much easier to replenish fuel-supplies, and decreases the number of firemen by 50 per cent. The determining factor in regard to the extended use of oil-fuel is now, as it has been for the last twelve years, the question of adequate supplies at reasonable rates. Reciprocating engines still hold the field in the mercantile marine, and are described at length in their latest forms. Condensers, evaporators, feed-water systems, superheaters, and other accessories also come under review; and so does auxiliary machinery of various kinds—including steering and capstan engines, refrigerating apparatus, air compressors, hydraulic machinery, electrical apparatus, and other classes of machines, all of which are essential to the efficient working of a modern steamship. The care and management of propelling and auxiliary machinery and boilers in a modern steamship involve great responsibility, and an interesting section of the book is devoted to the discussion of the preservation and repair of boilers, the adjustment of machinery, and the duties of the watch-keeping engineer. A comparatively brief sketch is given of the modern theory of the resistance experienced by ships when moving through water, and of the conditions influencing the efficiency of propellers. In all cases the author illustrates his conclusions by modern instances and recent experiments, showing himself to have been a diligent student of published data. This is a distinctive feature of the book throughout.

The final section describes "recent developments" in marine engineering, including marine steam turbines and the applications of internal-combustion engines to ship propulsion. The Parsons type of turbine naturally receives most attention, having been applied so much more extensively than any other type, and the descriptions and illustrations are excellent. The arrangements of turbine machinery described include those of battleships, cruisers, the latest Cunarders, and certain small, swift vessels of the destroyer class. A summary of the results obtained on contract trials and actual service is also given. It is interesting to note how rapidly the Parsons system has made its way abroad as well as at home. So far, its only rival—and that at a very great distance—is the Curtis turbine, which has been successfully applied in the United States scout-cruiser *Salem*, of which the contract trials took place subsequently to the completion of the book.

In regard to internal-combustion engines the author gives much information, indicating the features in which they must still be regarded as experimental, as well as those in which they promise a possibility of further advances in speed and fuel-economy.

The volume is well produced, has a good index, and contains about 400 illustrations. It deserves and will secure a good reception from all who are interested in the subjects of which it treats. The author has the courage of his opinions, and, in not a few instances, exception may be taken to his conclusions; but in all cases the materials for judging independently are given, and readers can claim no more.

W. H. White.

## THE MOON'S MOTION.

*The Inequalities in the Motion of the Moon due to the Direct Action of the Planets.* By Prof. E. W. Brown, F.R.S. Pp. xii+93. An Essay which obtained the Adams Prize in the University of Cambridge for the Year 1907. (Cambridge: University Press, 1908.) Price 6*s*. net.

PROF. BROWN is much to be congratulated on having at length written the word "Finis" to his lunar theory. His achievement has been a very great one, for he has completely solved the problem that he had proposed to himself, viz. the motion of the moon under the attraction of known bodies; he has pushed his solution sufficiently far beyond the standards required by observation to cover any probable increase in the accuracy of observation during the near future; his mathematics have been elegant, and his numerical computations performed under systems of check that command, not only his own confidence in their accuracy, but that of his readers. At last, therefore, we are entitled to say that any discrepancy between theory and observation must be attributed to fresh causes and not to imperfect calculation. A similar remark has somewhat readily been made before after the completion of other lunar theories, but a degree of numerical accuracy far beyond Hansen or Delaunay may safely be claimed for Prof. Brown's theory.

The memoir especially under review is the investigation of the direct action of the planets, which was recently awarded the Adams prize in the University of Cambridge. The subject was unknown to Hansen, whose tables are still in use. In 1876 Prof. Newcomb discovered an empirical term in the moon's motion. Shortly afterwards Mr. Nevill attributed this term to the action of Jupiter. Some years then elapsed, and Dr. G. W. Hill gave a computation of the new term, and a little later Radau computed a large number of planetary terms in the moon's longitude. It is remarkable that both Hill and Radau gave $0''\cdot90$ as the coefficient of Newcomb's term, and both of them were 20 per cent. in error. Radan's results are in other respects free from sensible error, and it is unfortunate that the term which started the whole subject should have been the one most difficult to calculate with accuracy. Quite recently Prof. Newcomb and Prof. Brown have published their researches. It is clear that the latter has reached a higher order of accuracy, but the former's memoir is probably amply good enough for comparison with observation. They agree in an increased coefficient of $1''\cdot1$ for Newcomb's empirical term. It is not possible to compare either investigation with the other at any intermediate stage before the conclusion.

This is perhaps the time to give an answer to the question, How will the actual motion of the moon agree with Prof. Brown's theory? We have already expressed our belief that any want of agreement will point to the action of unknown causes. Possibly, therefore, Prof. Brown's work will be even of more importance if his tables fail to predict the motion of the moon than if they succeed.

As regards short-period inequalities, we believe that Prof. Brown's tables will be practically perfect. We should like, however, to invite the attention of astronomers in thirty years' time to one point. Let every discordance between observation and tabular position be multiplied by the sine and cosine of the moon's longitude and the mean taken. If this be done for the last fifty years, the result is too large to attribute to accidental error; nor will the alteration of the moon's parallax and the insertion in the new tables of a Venus term with coefficient $0''\cdot7$ entirely remove the difficulty. Possibly the past observations have been affected by a systematic error, but be the cause what it may, the point is worth remembering and looking into when the proper time comes.

As regards inequalities of period over twenty years, Prof. Brown has thrown no fresh light upon the matter. Let us say quite plainly that we do not believe this to be Prof. Brown's fault. We do not doubt that his work is accurate, and because he has not explained certain long-period inequalities which appear to exist, we believe that the cause of those inequalities is something outside the problem that Prof. Brown proposed to himself. Nevertheless, we have only to look down the list of mean errors for each of the last fifty years to see that there still exists some unsolved mystery.

The mystery becomes greater the further we go back. Prof. Newcomb has investigated and is still investigating the occultations of the seventeenth and eighteenth centuries. In 1883 an empirical correction was introduced into the ephemerides to satisfy these occultations, and Prof. Brown's researches do not bring forward any fresh term that will take the place of Prof. Newcomb's empirical term.

If we go further back still, matters are worse. Many years ago Prof. Celoria traced the eclipses of 1239 and 1241 across Europe, collecting records from large numbers of different sources, and he pointed out a disagreement with the paths as calculated from Hansen's tables. The discordance becomes more accentuated as we go further back, until Prof. Newcomb declared that all records of ancient solar eclipses were to be put aside as untrustworthy. We do not think that this conclusion will stand, for two or three investigators have shown that the discordance between the records and the tables is not haphazard, but obeys an empirical law to which different forms may be given, but which is in its effect upon eclipse tracks very much the same in the different investigations referred to. Our conclusion, therefore, is that a splendid mathematical achievement has been performed, but that our power of predicting the motion of the moon has not been increased in a corresponding degree.

## PRO'S AND CON.'S OF DARWINISM.

(1) *Selectionsprinzip und Probleme der Artbildung: ein Handbuch des Darwinismus.* By Prof. Ludwig Plate. Dritte, sehr vermehrte Auflage. Pp. viii + 493; 60 figs. (Leipzig: W. Engelmann, 1908.) Price 12 marks.

(2) *Die Lehre Darwins in ihren letzten Folgen.* By Max Steiner. Beiträge zu einem systematischen Ausbau des Naturalismus. Pp. vii + 244. (Berlin: Ernst Hofmann and Co., 1908.) Price 3 marks.

(1) PROF. L. PLATE'S "Selektionsprinzip" has been so much expanded in its third edition that it deserves to be called "a handbook of Darwinism." It is a careful and thoughtful text-book by a thorough-going Darwinian, who is at the same time a believer in the transmission of acquired characters. In the first chapter he considers the objections to Darwinism. These may be relatively unimportant, *e.g.* that Darwinism does not account for the origin of variations, that artificial and natural selection are not really analogous, that the struggle for existence is not selective. But there are other objections which are more essential, *e.g.* that minute changes cannot have selective value, that the process of natural selection cannot be seen occurring, that the theory of selection starts from the fortuitous. It is useful to have a modern Darwinian's answers to these and other attacks on his faith, and it is much to be desired that those who rush into print with anti-Darwinian books and essays would read a work like Plate's, especially if they will not read Darwin.

The second chapter gives a careful discussion of the various forms of struggle and selection. The third discusses the auxiliary, or would-be auxiliary, theories—theories of sexual selection, struggle of parts, panmixia, germinal selection, and mutation; and the author deals in a strongly critical but temperate manner with the difficulties which beset these. He will have nothing to do with germinal selection and not much with Roux's "Kampf der Teile"; panmixia may account for degeneration, but not for rudimentation, and most of what is new in the mutation-theory is not true. Apart from selection, the conditions of evolution are heritability, variability, and isolation; and the discussion of these is admirable. One may not agree—and we certainly do not feel in any way convinced by the author's vigorous Lamarckism—but one must admit that the author's presentation is skilful and just. He states the experimental and other facts which lead him to think that we cannot dispense with modification-inheritance, and he sketches a hypothesis, not unlike Herbert Spencer's, of the passage of a specific influence from the peripheral parts of the soma to the penetralia of the germ-cells. Plate is far from thinking that the selection-theory clears up everything; it starts with growing and multiplying organisms which it does not explain; the conditions of variability and inheritance are still unknown; there are many unsolved problems. But instead of making a harsh alternative between the "Allmacht" or "Ohnmacht" of natural selection, what we have to do, as the author well indicates, is to test this and other formulæ in a critical yet fair-minded fashion. This is what he has aimed at in his book, and it seems to us that he has succeeded well, on the whole, at any rate, for now and again, *e.g.* in his remarks on the vitalists, he seems to us to be unnecessarily hot-blooded. We should like to know, for instance, where Dr. Hans Driesch spoke of a "Degeneration des Gehirns der Darwinisten." Is this not a fictitious quotation?

(2) The author of the second volume before us seems to think that Darwinism has been too much discussed as a biological theory, artificially abstracted from its social consequences. If we understand him, he seeks to put things right by showing what terrible consequences the theory involves. A scientific formulation is not to be judged by its applicability to the order of facts in relation to which it arose—that is a humdrum conventional inquiry which may be left to men like Prof. Plate—it must be judged by its human consequences! So Herr Steiner expounds with gusto his by no means favourable judgment of the metaphysic and ethic of Darwinism and its bearing on æsthetics and the valuation of life. He shows to

what dreadful places the Darwinian path leads. He applies the pragmatist test: What is this hypothesis good for? and he finds that it is not good either for a man's metaphysics or for his morals. This mode of testing scientific conclusions seems a dangerous one. It brings the passions and noise of the market-place into the dispassionate and quiet walks of science. In many pages the author seems to us to be caricaturing Darwinism, and while his work may be of use in showing the danger of hastily transferring biological results into the ethical and social realm, it seems to us to be full of exaggerations and fireworks. Some well-meaning writers have done ill-service by hastily transferring to the human social realm the imperfect results of a rapidly changing biological ætiology which would be better pleased to be left to mind its own business, but it seems to us even more deplorable that an author of Max Steiner's ability should prejudice judgment on Darwinism by showing in lurid colours what *might be* the social, ethical and æsthetical consequences of certain biological doctrines or misinterpretations of these. J. A. T.

## *THE STUDY OF TROPICAL DISEASES.*

*The Practical Study of Malaria and other Blood Parasites.* By Dr. J. W. W. Stephens and S. R. Christophers. Pp. iv+414+xiv. Third Edition. (Liverpool: The University Press; London: Williams and Norgate, 1908.) Price 12*s.* 6*d.* net.

THE issue of three editions of this book in the space of five years is eloquent testimony to its usefulness, and we can well understand that, to the worker in the tropics, far away, perhaps, from libraries, laboratories, and fellow-workers, it is invaluable. The authors are both well known for their researches on tropical diseases, and Dr. Stephens is lecturer in the Liverpool School of Tropical Medicine, so that they know the needs of the research student. In the present edition various alterations have been made—trypanosomes, the Hæmamœbidæ and spirochætes are described at greater length than before, the chapter on ticks has been re-written and extended, the consideration of mosquitoes has been confined to the Anophelinæ, and the chapter dealing with Filariæ has been omitted.

The last-named omission is, in our opinion, a mistake, for this section added much to the completeness of the volume, without enlarging it to too great an extent. The book is profusely illustrated with rough but characteristic sketches, more finished drawings, and coloured plates, which enhance its value.

The first two chapters deal with the normal and pathological cells of the blood, their enumeration, and staining. In the drawing of the megaloblast (Fig. 1, p. 2), the nucleus is depicted too deeply stained, and it is hardly correct to describe the nucleus of the large mononuclear leucocyte as irregular and much indented. The caution to use pure methyl alcohol in making up the Leishman stain might have been emphasised. Chapters iii., iv., and v., on malaria, are concise and to the point, and embody a number of useful practical "tips." We miss, however, any reference to the term "subtertian," now commonly used to designate the malignant tertian fever. Chapters vi. to xix. deal with mosquitoes—their general structure, development, life-history, habits, and classification, methods of examination, breeding, capture, and identification. As regards killing, no mention is made of the ordinary entomologist's killing bottle, which can often be obtained or extemporised, and when at hand is one of the best methods available. As regards classification, that of Theobald is adopted, which is based largely on the characters of the scales on the wings and body. The authors are probably wise in confining their description of species almost to the Anophelinæ; these are the important ones from the point of view of medical research, and to have included much more would have occupied far more space than could be allotted. Chapter xxi. is a useful one, indicating how to make a malarial survey of a district. In chapter xxii. the clinical study of malaria is detailed, and contains much useful information. The Hæmamœbæ, hæmogregarines and Piroplasmata are next considered, and the occurrence and main characters of the important species described. We note that it is stated that Miyajima cultivated a trypanosome in blood bouillon from *Piroplasma bigeminum*, but this is an error; the species giving rise to these flagellated developmental forms was probably *P. parvum*. The consideration of ticks naturally follows that of the Piroplasmata, and a very full description of these arthropods is given; but in the classification and description of species more mention of synonyms would have been helpful. The trypanosomes are next considered in great detail, and a chapter on biting flies, *e.g.* Stomoxys, Tabanus, and Glossina, concludes the descriptive matter.

The book also includes chapters on blackwater and yellow fevers, and an appendix containing formulæ for stains and other solutions, preparations of tissues, weights and measures, &c.

We congratulate the authors on their work, which will be indispensable in all laboratories.

## *HUMAN PHYSIOLOGY.*

*Physiologie des Menschen.* Von Dr. L. Luciani. Ins Deutsche übertragen und bearbeitet von Prof. Dr. S. Baglioni und Dr. Hans Winterstein. Sechste bis zehnte Lieferungen. (Jena: Gustav Fischer, 1907.)

THE issue of the sixth to tenth parts of Luciani's text-book of physiology nearly brings the work to a conclusion. Within the limits of a review it is only possible to mention the most salient features of the book.

Part vi. deals first with the excretory functions of the intestines. The description is noteworthy, not only on account of its excellence and completeness, but also because it indicates more fully than is usual in text-books of physiology the important bearing of the facts on practical medicine.

In the next chapter the chief chemical constituents of the urine are enumerated and described. In view of the large number of works entirely devoted to this subject, the author has wisely limited his account to the more important facts. It is somewhat unfortunate that Hopkins's method for the estimation of uric acid has been omitted, since it is much simpler than that of Salkowski and Ludwig, which has been selected by the author. A considerable amount of space is devoted to the subject of the toxicity of the urine under normal and pathological conditions. A comprehensive account is next given of the various theories dealing with the secretion of the urine. The description of the functions of the urinary system concludes with a very full and lucid review of the functions of the bladder.

The physiology of the skin and its glands forms the subject of the next chapter. The final pages of the section are devoted to a very thorough and interesting description of the histological and chemical changes involved in the secretion of milk.

Part vii. deals first with the general physiology of muscle. An exceptionally complete account is given of the methods employed in studying muscular work. The mechanics of the special organs of motion are also discussed in greater detail than is usual in text-books of physiology. A description of the mechanism of voice production forms a natural conclusion to this chapter.

The following chapter gives a clear and detailed account of the general physiology of the nervous system, and includes several hitherto unpublished figures from Golgi. An excellent critical review of the neurone theory of the constitution of the nervous system forms a prominent feature of this section. The recent work of Verworn and his pupils on the hitherto somewhat obscure subject of the metabolism of the nerve centres is fully described. The recent interesting experiments of Baglioni and Winterstein on the isolated cord of the frog are also included in this chapter. The physiology of the spinal cord and its nerves forms the subject of the next chapter. A noteworthy feature is the very lucid and thorough description of the segmental distribution of the spinal nerves. Baglioni and Winterstein—the translators of the work—have added a very useful summary of the physiology of the sympathetic nervous system.

The physiology of the bulb and associated cranial nerves is next described in detail. In the following chapter, a very valuable and critical account is given of the physiology of the cerebellum, largely based upon the author's own work.

The two final chapters deal with the physiology of the mid-brain, basal ganglia, and cerebrum. They embrace a very comprehensive survey of the historical development of our knowledge up to the most recent date. A masterly description is given of the localisation of the sensori-motor, sensory, and association centres in the cerebral cortex of man and the higher mammals.

It would be difficult to speak too highly of the value of this text-book. Its preparation must have entailed an almost incalculable amount of labour, combining as it does that wealth of detail usually only found in text-books written by numerous contributors with the uniformity of treatment resulting from the fact that it is essentially the work of one author. The account of the nervous system especially reveals an exact and intimate knowledge of the literature. The work of English physiologists in this field receives fuller treatment than in most foreign text-books.

The translators of the work—Baglioni and Winterstein—have made many valuable additions with the object of bringing the book fully up to date. The book is remarkably free from typographical errors. The following errata, however, should be noted:—on p. 370 of vol. ii. "phenol" is used instead of "indol," and on p. 600 of vol. iii., in the description of Flechsig's scheme of the projection and association centres, "parietal" is used instead of "frontal." In one instance also the word "verleiten" is used instead of "verleihen." J. A. MILROY.

## TECHNICAL CHEMISTRY.

*Leather Industries Laboratory Book of Analytical and Experimental Methods.* By Prof. H. R. Procter. Second edition, revised and enlarged. Pp. xx+460. (London: E. and F. N. Spon, Ltd.; New York: Spon and Chamberlain, 1908.) Price 18*s*. net.

AS the first edition of this work has been out of print and unobtainable for more than two years, the appearance of a second and revised edition is extremely welcome to those who are in any way connected with the leather and allied trades.

The second edition of this work is similar in style and external appearance to the first edition, but has been considerably enlarged and in parts completely re-written. Prof. Procter has added new methods of analysis for the control of the tan-yard, in some cases as supplementary to the old, but in others has substituted the newer methods as being more accurate; and as the author states in the preface that "they have been carefully tested in my own laboratory," the dictum of such an authority will suffice to satisfy all chemists working in this branch. The work is not meant to teach either chemical theory or the principles of leather manufacture, but contains in handy form practically all the various common analytical methods likely to be required either by the chemist in the tannery or by those doing work in connection with the chemistry of the leather and allied trades. It is not intended to take the place of ordinary chemical text-books, but to supplement them; and throughout the volume the fullest references are given to original papers and methods.

The work deals in various chapters with general methods of analysis, technical water analysis, depilatants, the estimation of ammonia and hide substance, the analysis of materials used in puering, bateing, liming, &c. Chapter viii., dealing with the chemistry of the tannins and their derivatives, has been considerably enlarged and brought up to date. In this the author has summarised all the work which has been done on this subject up to the present time, and gives copious references. The chapters dealing with the analysis of tanning materials and the official methods of tannin estimation have been completely re-written, and full details of the new international method of tanning analysis are given. The subsequent chapters deal with the estimation of colour in tanning materials, the analysis of used tan-yard liquors, the analysis of alum and chrome. In connection with this last-named subject the author gives some valuable practical information on the making up of chrome liquors in the testing of liquors in use. This branch of leather manufacture has progressed by enormous strides during the past ten years.

The next chapters deal with the estimation of adulterants in leather, the analysis of soaps, oils and fats, and a table of important constants for oils and fats used in the leather trade is given, and the effect of various fats on leather explained. The analysis of leather, dyes and dye-stuffs follows. The last three chapters are devoted to the use of the microscope, the structure of the skin, and bacteriology. These have been largely re-written, and the author has added some fine photomicrographs of adulterants in tanning materials, and indicates the value of the use of the microscope in competent hands. The bacteriology and mycology of tanning is gone into thoroughly, and our somewhat scanty information on this subject brought up to date, the rapid growth of our knowledge of this most important branch being made evident.

The work is illustrated and printed on good paper, and is written in Prof. Procter's well-known clear style.

At the end of the book some blank leaves are bound in, so that pending the arrival of the third edition those using this book may add notes, and so keep the volume up to date. With such a volume as this before us one is almost tempted to say that after all science has secured a firm foothold in one of the most conservative trades existent.

J. Gordon Parker.

## *OUR BOOK SHELF.*

*Geology and Mineral Resources of the Western Coalfield.* By J. E. Carne. Pp. xii+264; with 37 plates and portfolio of maps and sections. (Sydney: Geological Survey of New South Wales, 1908.) Price 15*s*.

In New South Wales the existence of beds of coal was known in very early days, and was the reason for the name of the colony. It is calculated that New South Wales has yielded altogether 138½ million tons of coal, the output last year alone having exceeded 8½ million tons. In addition to coal, the kerosene shale deposits are of considerable importance, and are at present attracting attention owing to the introduction of British capital for their development. Mr. Carne's elaborate monograph, which reflects great credit upon himself and upon the Geological Survey, is consequently a work of the utmost importance to the mining industry, as well as a valuable addition to scientific literature. With the accompanying portfolio of coloured geological maps and sections, it forms the first instalment of a systematic geological survey of the productive Permo-Carboniferous Coal-measures of New South Wales. The total area mapped and described in this memoir amounts to 2877 square miles, of which 2261 square miles may be regarded as productive. The country described embraces the principal parts of Cook and Hunter counties, and a large portion of Roxburgh and Phillip counties, the greater part of the Blue Mountains being included. From an economic point of view, coal and kerosene-shale are the chief assets of the country mapped. Limestone, firebrick, pottery clays, building stones, and iron ore follow in order. The smelting of local iron ore has been successfully begun at Lithgow; and if the iron-smelting venture and the extensive development of the kerosene-shale export and retorting industry continue to progress, the district will soon become a great centre of industrial activity. The picturesque character of the country is well shown in the numerous admirable illustrations accompanying the memoir. Massive Triassic sandstone, imparting boldness to the scenery, is sculptured by denudation into rugged walls and isolated masses. Irregularities of the plateau are not less varied. Huge domed laccoliths, conical volcanic peaks, and flat coulee remnants are everywhere prominent. A glance at the illustrations impresses one with the magnitude of the task of geologically surveying these mountains, which in 1788 effectually barred Governor Phillip's progress into the interior from the settlement on the shores of Port Jackson. The persistence of the explorer of the present day in forcing his way along jungle-fringed and boulder-strewn streams flowing through deep cañons and almost impassable ravines is hardly less astonishing than that of the first surveyors, who, far from an accessible base of supplies, traversed this unknown and inhospitable region.

*Science and Empiricism.* By H. C. Daniel. Pp. 29. (London: Scientific Press, Ltd., 1908.) Price 1*s*. 6*d*. net.

This booklet contains a strange medley of fact and fiction, though apparently written with a good motive, for in his preface the author acknowledges the "splendid efforts of our scientists and medical professors," and deplores "the neglect of hospitals and laboratories." In section i. the author discourses on biology and Weismannism; in section ii. on pathology, with special reference to cancer and its cure, in which we are exhorted "in the place of fiction to substitute truth. Instead of holding to the absurd principle that the red corpuscles are the bearers of oxygen, let us in the future build upon the more scientific principle that oxygen is the bearer of the red corpuscles." Cancer is easily explained. "Superficial cancer is a disease of the blood tissues and is only dangerous is so far as it affects the tissues or envelope of life. Plasmic cancer, however, is a disease of the oxygen or vital ground, that is to say, of the white corpuscles or physical unity of life, and as such it goes deeper than the tissues." The seven last pages are devoted to sections on theology, education, and government, but what they are all about we really are not quite sure! R. T. H.

*Vegetationsbilder.* Edited by G. Karsten and H. Schenck. Sixth Series. Part i., Samoa. By Karl Rechinger. Part ii., New Guinea Archipelago. By Karl Rechinger. Part iii., North-Eastern Brazil. By E. Ule. Part iv., The Algerian Sahara. By H. Brockmann Jerosch and A. Heim. Parts v. and vi., Alpine Vegetation. By H. Schenck. (Jena: Gustav Fischer, 1908.)

The sixth series of the "Vegetationsbilder" fully maintains the reputation of the preceding volumes. The pictures of Samoan vegetation furnish an indication of the humidity of the climate where ferns supply 25 per cent. of the higher plants. Illustrations are provided of *Polypodium sabauriculatum*, an epiphyte in the rain forest, *Angiopteris evecta*, growing by the streams, and *Todea Fraseri*, an endemic species of the genus, also of a peculiar liliaceous epiphyte, *Astelia montana*. As characteristic plants of the Solomon Islands there are figured the epiphyte *Polypodium quercifolium*, an expanse of "alang-alang" grass, *Imperata arundinacea*, and a huge specimen of *Calophyllum inophyllum* growing close to the sea. A fine photograph of the stilt-roots of a Ficus is contained in this part. Mr. E. Ule has contributed the photographs from the "campos" in the Brazilian State of Bahia. Various cactus plants are illustrated, also some of the abundant leguminous trees. The cluster of palms, *Copernicia cerifera*, the species yielding Carnauba wax, forms an imposing group. The number devoted to the Algerian Sahara is also a xerophytic study. The plates include representations of *Limoniastrum Feëi, Aristida pungens,* and *Pistacia terebinthus*. In the final double number Dr. Schenck presents some excellent studies of plants in the Swiss and Tyrolese Alps. The photographs that more particularly evoke admiration are those showing cushions of *Androsace helvetica*, flowers of *Ranunculus alpestris*, clumps of *Thlaspi rotundifolia,* and straggling plants of *Salix retusa*.

*British Rainfall*, 1907. By Dr. H. R. Mill. Pp. 100+[280]; with maps and illustrations. (London: E. Stanford, 1908.) Price 10*s*.

THIS excellent work, which has now reached its forty-seventh annual volume, has, by the energy and ability of its founders, established for itself a unique position among general rainfall publications. It deals with the distribution of rain in space and time over the British Isles during the year 1907, as recorded by more than 4000 voluntary observers, and is supplemented by articles upon various branches relating to that subject. As it has appeared in practically the same form for many years (which is a great advantage for the purpose of reference), there is little to be said about it that has not been previously mentioned; the work of the British Rainfall Organisation is continually expanding, and the author receives no pecuniary assistance in the onerous labour of preparation and publication of the report beyond some subscriptions from persons interested in rainfall work.

Among the articles we may specially refer (1) to an interesting discussion of the typical thunderstorms of July 21–22, showing distinctly the linear arrangement of heavy rainfall in such storms and its disregard of the configuration of the land, and (2) to an instructive note on mapping rainfall. The discussions of droughts and rain spells, and the monthly and seasonal charts illustrating the rainfall of the year, are also of exceptional interest.

*Arbeiten aus dem Gebiet der experimentellen Physiologie.* By Dr. Hans Friedenthal. Pp. xi+493. (Jena: G. Fischer, 1908.) Price 8 marks.

THIS is a collection of fifty-five papers written either by Dr. Hans Friedenthal or by the workers in his laboratory. Dr. Friedenthal does not appear to have any university or other official post, but is the happy possessor of a private laboratory at Nicolassee, near Berlin, and he seems to be a prolific and versatile worker. The first paper of the collection is an obstetric one, written in 1894, but subsequently the various branches of physiological investigation appear to have had greater attraction for him, and he has produced since that time publications dealing with such subjects as absorption, immunity, digestion, colloids and ions, cardiac and sympathetic nerves, cancer, syphilis, the urine, and histological methods. The papers themselves are of considerable interest, and the collection is one of which any investigator may well be proud.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### Observations on the Active Deposit of Radium in Mid-ocean.

IN the month of May, 1908, by the kindness of the captain and officers of the ss. *Lake Erie*, observations were made between Montreal and Liverpool on the radio-active matter collected on a negatively charged wire exposed to the air for three or four hours. The wire was insulated by ebonite rods, suspended from the flag halyards, and charged by a Zamboni dry pile. After exposure it was coiled on a skeleton reel and placed in an electroscope clamped to a board, together with the observing microscope. There was no difficulty in obtaining satisfactory readings, in spite of the slight motion of the ship.

The results obtained in mid-Atlantic appear to approximate to those found in Canada or in England, but it must be remembered that the amount of active deposit determined at any given locality is liable to considerable variations.

To an arbitrary scale, after deducting the natural leak, the measurements of the active deposit were as follows:—

| | | |
|---|---|---|
| May 5. | Montreal ... ... ... ... | 34 |
| ,, 6. | ,, ... ... ... ... | 26 |
| ,, 14. | Ocean, lat. 50°, long. 45° ... ... | 21 |
| ,, 15. | ,, ,, 52°, ,, 38° ... ... | 64 |
| ,, 16. | ,, ,, 54°, ,, 30° ... ... | 41 |
| July 1. | Hornsea, E. Yorkshire Coast ... | 28 |
| ,, 2. | ,, ,, ,, ... ... | 80 |
| ,, 15. | ,, ,, ,, ... ... | 53 |
| ,, 20. | ,, ,, ,, ... ... | 60 |
| ,, 22. | ,, ,, ,, ... ... | 48 |
| Aug. 22. | Seascale, W. Coast, Cumberland ... | 30 |
| ,, 24. | ,, ,, ,, ... | 270 |

The large value at Seascale on August 24 was obtained on a vertical wire well exposed to a strong west wind. The small values at Montreal resulted from a horizontal wire on the roof of a house. An uncharged wire at sea gave no result.

These experiments, so far as they go, indicate that the active deposit due to radium is prevalent to nearly the same extent over land and sea. Observers have also found that the ionisation of the atmosphere, measured by Ebert's apparatus, is nearly the same over the ocean and over the land.

We may deduce, then, that in mid-ocean the radium emanation, which decays to half value in 3·8 days, and gives rise to the active deposit, cannot be entirely wind-borne from the land, but that the emanation enters the air from the ocean somewhat as from the ground.

This is contrary to expectation, for the average number of grams of radium per c.c. of rock is about $3{\cdot}5\times10^{-12}$ (Strutt) and per c.c. of sea water $3\times10^{-14}$ (Joly). It is, however, probable that the emanation due to radium in solution in sea-water escapes more readily than the greater quantity generated in soil or rock. The emanation per c.c. in the atmosphere near the earth's surface would be in equilibrium with about $6\times10^{-17}$ grams of radium.

Montreal, September 22. A. S. EVE.

### The Indigo Question.

IN an admirable article, "A Contribution to the Indigo Question," which appeared in NATURE of July 30 (p. 296), Prof. Meldola discusses the report of the work carried on by Messrs. Bloxam, Wood, Orchardson, Gaunt, and Thomas in the clothworkers' laboratory at Leeds University, and agrees with the authors in the opinion they express that there is still scope for considerable improvement in the manufacture of natural indigo. On the other hand, the general secretary of the Bihar Planters' Association (Mr. T. R. Filgate), in replying to this article (NATURE, October 1), makes the remarkable statement, "nothing further can be done in improving the main processes."

Although Prof. Meldola has already dealt with this statement, I should like to be allowed to make a few remarks on the same subject. The most important point in the whole discussion is the question whether, in the future, it will be possible for the natural product to compete successfully with its coal-tar rival.

If the planters and their adviser, Mr. Bergtheil, can be induced to recognise and extend the results of the scientific investigations carried on in Leeds under my general supervision, I am strongly of opinion that there is still a bright future for natural indigo. The details of these investigations have been published in the Journal of the Society of Chemical Industry, and I cannot go into them again here, but I may be allowed briefly to state the main conclusions which were arrived at and confirmed in the fullest possible manner.

There can be no doubt that the indigo leaf contains much more indican than was formerly supposed to be the case, and this fact has hitherto been overlooked because of the defective analytical methods employed by the scientific advisers to the indigo planters. Mr. Bloxam and his colleagues very carefully investigated these analytical processes, and were able to prove conclusively that the persulphate method, carried out according to Mr. Bergtheil's directions, gives results which are quite untrustworthy. The first step, therefore, was to devise trustworthy analytical methods, and this was ultimately accomplished by the development of the isatin method for determining the indican in the leaf and the tetrasulphonate method for estimating the indigo in the finished cake. A very large number of control analyses, carried out under a great variety of conditions, have shown conclusively that these analytical methods are the only ones which give accurate results. The application of these new methods has proved beyond doubt that there is much more indican in the leaf than is converted into indigo under the present conditions of manufacture. In spite, therefore, of the statement of the general secretary of the Bihar Planters' Association that "nothing further can be done in improving the main processes," I am convinced that there is a great prospect of considerably increasing the yield of indigo provided all the details of manufacture are systematically subjected to searching and skilful scientific investigation.

A. G. Perkin.

### Memory in the Germ-plasm.

If "a lamb's tail is shortened" and the germ-cell "records" the event, surely there is more to be "remembered" by it than a "momentary cut," viz. a permanent change of shape? Setting aside mutilations, there remain use-acquirements. From infancy forwards a man develops physically and mentally, principally under the stimulus of use. For instance, the muscles of an infant's limbs do not grow unless used. His mind is almost blank at birth, but grows under the influence of experience (use). In this way he learns to coordinate his muscles and a vast deal more. Prolonged parental protection affords the opportunity. In proportion as animals are low in the scale of life they appear to be less and less capable of making use-acquirements until they are quite incapable. Most insects, for example, are not protected by their parents, and must come into the world fully equipped physically and mentally to cope with the environment. They have no need for use-acquirements, and apparently make none. It seems clear, then, that the power of developing under the stimulus of use (plasticity, as it is called) is a product of evolution. It confers the immensely valuable trait of adaptability on the individual. The position, then, appears to be this: low animals cannot make use-acquirements, and therefore can transmit none; higher animals can make use-acquirements, but obviously transmit none, for in them the innate has been progressively replaced by the acquired. When we speak of the transmission of a use-acquirement, we do not really mean that the child has inherited the parental trait—we mean that the trait has been *transmuted* into something very different and much less useful, an innate character. In other words, we suppose that the adaptability of the parent is replaced by rigidity in the child, and we suppose this in spite of enormous and conclusive evidence to the contrary. We close our eyes carefully to facts, and found our science on vague analogies.

Southsea, October 9. G. Archdall Reid.

### A Red Rainbow at Sunset.

October 9 was a mild day with south-west wind, and slight showers in the afternoon. The sky was overcast until sunset, when breaks appeared in the clouds. In the west there was a fine effect of orange-yellow sunset colour, while in the south-east at the same time the clouds were pink. Here, on some pink clouds near the horizon, a fine, nearly vertical patch of rosy-red rainbow appeared, which shone more brilliantly, and was of a rather yellower red than the surrounding clouds. The colour, varying in intensity, lasted for about three minutes, and the patch appeared to be from 10° to 12° in length; the occurrence took place about 5h. 30m. G.M.T. A similar rainbow is described in the current number of the *Gazette astronomique*.

E. Armitage.

Dadnor, Herefordshire, October 10.

## OXFORD UNIVERSITY MUSEUM.

The fiftieth anniversary of the opening of the Oxford University Museum was celebrated on Thursday last, and a large number of distinguished men of science, representing the universities and scientific societies and institutions of Great Britain and Ireland, assembled to do honour to the occasion. The proceedings were short, and may be very shortly described. The guests assembled in the Sheldonian Theatre, where the honorary degree of Doctor of Science was conferred on Prof. Svante Arrhenius and Mr. A. G. Vernon Harcourt. Fifty years ago Mr. Harcourt was acting as Brodie's lecture assistant, and was engaged in setting up the apparatus for the first lectures delivered in the new museum. Hearty congratulations were tendered by those present on his unimpaired vigour and energy after so many years' active and distinguished scientific work. After receiving congratulatory addresses from universities and learned societies, the Vice-Chancellor read a letter from the Chancellor, and delivered an address which was singularly felicitous both from its style and from the evident sincerity with which he expressed his sympathy with the progress of scientific studies in the University of Oxford.

In the afternoon Dr. Vernon Harcourt gave an address on the early history of the museum. It was unfortunate that the lecture theatre of the museum was too small to accommodate a larger audience. Many were unable to gain admittance, but those who were more fortunate had the privilege of hearing an interesting story luminously told, and enlivened by many humorous passages and personal reminiscences. After Dr. Harcourt's address, the Vice-Chancellor unveiled a bust of the late Prof. W. F. R. Weldon, and the company dispersed to tea and to visit the various departments of the museum.

Though, as the Vice-Chancellor said in his address, fifty years is not a long period in the history of education nor in the history of the University of Oxford, it was fitting that this anniversary should have been commemorated. The building of the Oxford Museum was an indication of a great change in the opinions of educated men in this country, and it is probable that half a century hence the present time will be looked back upon as equally important in the history of the progress of scientific education. In our opinion, too much stress has been laid upon the opposition to the project of building the University Museum; too little credit has been given to the large and enthusiastic support which enabled the project to be realised.

It must not be supposed that Oxford was entirely destitute of scientific collections or of scientific professors and readers in the earlier part of the nineteenth century. The Ashmolean Museum, housed in the beautiful building designed by Wren, contained a considerable number of natural history specimens as well as objects of antiquarian interest, and though it had suffered neglect in the eighteenth century, it had been largely added to by the indefatigable zeal of J. S. and P. B. Duncan since 1823. There were collections of geology and mineralogy in the Clarendon building. Dr. Kidd and the late Sir H. Acland had formed an important anatomical collection at Christ Church, on the model of the Hunterian Museum. Dr. Daubeny had equipped a private house near Magdalen College as a laboratory. The Botanic Garden at Oxford is one of the oldest of its kind. But university laboratories and lecture rooms can hardly be said to have existed, and if they had existed they would not have been filled, for there were no inducements to the study of natural science. In the earliest years of the nineteenth century Oxford had reformed herself. The system of honour examinations was instituted in 1801, and the colleges bestirred themselves to improve and systematise their methods of teaching. But the only subjects recognised in the final schools were "Literæ humaniores" and mathematics; for these exclusively college tuition was provided, and to these subjects alone were allotted all the profits and honours that the colleges could give. The advance in efficiency was no doubt considerable, but it took a direction hostile not only to scientific but to every kind of professorial teaching. Each college undertook to provide for all the intellectual wants of its members, and was jealous of outside interference. As the tutorial influence grew, the professorial influence waned, and the audiences of the scientific professors and readers in particular, if they existed at all, consisted chiefly of graduates who took a *dilettante* interest in natural phenomena.

When the exclusive interests of the colleges are considered, it is a remarkable instance of the liberal spirit prevailing in Oxford before the days of University Commissions that the Honour School of Natural Science was established by vote of Convocation in 1849, and that a large sum of money was shortly afterwards contributed by the University and by private individuals to the building of a museum and laboratories which would be independent of college influence. It is interesting to note that, among many others, Mr. Gladstone's name stands as a contributor of 100*l.* towards the museum building fund, and Dr. Pusey's name as a contributor to the internal decorations. Looking over the records, one cannot but be struck with the large amount of sympathy and practical help given by men whose interests in life lay in very different directions. Equally striking are the high ideals and noble conceptions of those who guided the course of affairs. The new museum was designed to include all the branches of natural science under a single roof, and thus to symbolise the unity of science. Great care was taken that the site and architectural features of the new building should be dignified; that the interior should be enriched with carving; that the history of science should be illustrated by statues of the great men of ancient and modern times. It is well known how Ruskin threw himself into the work and invested it with a poetical fancy which, if detrimental in some respects to the practical requirements of scientific laboratories and exhibitions, is not without value and influence at the present day. Lack of money prevented the completion of the enrichments originally designed, but in very recent years the generosity of the Rev. H. T. Morgan has provided for the carving of the capitals of the pillars of the south and east sides of the central court.

If Oxford was first in the field, it must be confessed that science has not made such rapid strides there as in other universites during the half-century that has elapsed since the museum was first opened. But the progress has been great, though retarded by influences the force of which has only gradually abated in the period. There can be little doubt that the highly elaborated system of college tuition, always more conspicuous at Oxford than at Cambridge, has been a retarding influence. Admirable as it is in many ways, this system has the effect of making colleges reluctant to allow their undergraduates to escape from their immediate influence. College tutors said that when their men went to the museum they lost sight of them. Hence, for many years, they discouraged their going there. As time went on, and it became evident that there was a real demand for scientific teaching, the colleges began to build and equip scientific laboratories of their own; mostly chemical laboratories, in response to the great demand for chemical instruction. Thus it has come about that a great part, probably the larger part, of the chemical teaching in the university is not conducted at the museum, but elsewhere. If this is theoretically disadvantageous, the college lecturers, by organising their courses in combination with the chemical department at the museum, have contributed very largely to the recent rapid progress of chemical science in Oxford, and, further than this, they have been the agents in spreading a real and active interest in scientific studies among all classes in the University. Year by year individual colleges come forward with proposals to endow scientific professorships in subjects insufficiently represented in the University. It would be invidious to particularise, and it would take too much space to enumerate all that has been done by different colleges in this direction in recent years, but special mention may be made of St. John's College, which, after re-endowing the Sibthorpian chair of rural economy, at its own expense has built and equipped laboratories and lecture rooms for the use of the professor.

But the most fundamental and certainly the most encouraging feature in the changed estimate of the value of scientific training in Oxford is due very largely, as the Vice-Chancellor pointed out, to the example set by science itself. By slow degrees the University has come to recognise the value of research. Not long since examinations and preparation for examinations absorbed the whole interest of college staffs. Success in examinations was the only road to a fellowship. In the last few years many colleges have so amended their statutes that they are able to elect a large proportion of research fellows, and have amply availed themselves of their new opportunities. New ideals and new opportunities have arisen, not only in natural science, but in all branches of learning, and the immediate effect, so far as science is concerned, is that emulation has taken the place of opposition.

Thus the celebration of the fiftieth anniversary of the museum marks, not the dawn, but the establishment of a new era. The progress of scientific studies depends more upon sympathy and good will than on laboratories and equipment, indispensable though the latter may be. Those who visited Oxford last week could easily take note of the numerous additions to the departments of the museum and satisfy themselves that the material for scientific work is not lacking. They could satisfy themselves with equal ease of the energy and enthusiasm of the scientific staff, but the spirit of the whole University is more difficult to discern. It should be noted, therefore, that the

Vice-Chancellor's address, which faithfully reflected the opinion of the great majority of resident graduates of the University, was one of the most satisfactory features of the day's proceedings. Nor was evidence lacking that where high ideals and earnest effort are present material assistance is soon forthcoming. The pathological department was largely built and equipped by private generosity, and the Drapers' Company, to whom the University is already indebted for a beautiful and commodious building for housing the Radcliffe library of scientific works, has undertaken to defray the expense of a new electrical laboratory for the use of the Wykeham professor of physics.

All well-wishers of Oxford may join in congratulating her on what she has already achieved, and not less on the abundant promise of future achievement.

## MEASUREMENTS OF THE CHINESE.

We have received from Mr. A. H. Crook, Queen's College, Hong Kong, average measurements of various dimensions of Chinese boys and youths between the ages of ten and twenty-four years, the most important of which we give below. The British Association averages for English boys of the same age, so far as they are available, are printed beneath the corresponding Chinese measurements. Mr. Crook points out an interesting difference in the growth curves of weight and height of the two races.

MEASUREMENTS OF CHINESE BOYS.

| Ages | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | 3 | 6 | 15 | 27 | 55 | 95 | 133 | 112 | 98 | 63 | 34 | 12 | 3 | 3 |
| *Weight.* | | | | | | | | | | | | | | |
| Chinese | 64·2 | 66·2 | 73·6 | 78·7 | 90·9 | 97·6 | 101·6 | 106 | 108·9 | 114·4 | 113·4 | 115·3 | 116·7 | 100·1 |
| English | 67·5 | 72·6 | 76·7 | 82·6 | 92 | 102·7 | 119 | 130·9 | 137·4 | 139·6 | 143·3 | 145·2 | 146·9 | 147·8 |
| *Height.* | | | | | | | | | | | | | | |
| Chinese | 54·1 | 54 | 56 | 59·6 | 62·2 | 62·9 | 63·5 | 64·2 | 64 | 65·7 | 65·6 | 65 | 64·6 | 62·4 |
| English | 51·8 | 53·5 | 55 | 56·9 | 59·3 | 62·2 | 64·3 | 66·2 | 67 | 67·3 | 67·5 | 67·6 | 67·7 | 67·5 |
| *Chest (Normal).* | | | | | | | | | | | | | | |
| Chinese | 24·8 | 24·6 | 25·6 | 26 | 27·5 | 28·7 | 29 | 29·3 | 30·1 | 30·3 | 30·5 | 30·5 | 31·3 | 29·7 |
| English | 26·1 | 26·5 | 27·2 | 28 | 28·5 | 29·7 | 31·5 | 33·6 | 34·19 | 34·5 | 35 | 35·2 | 35 3 | 35·6 |
| *Chest (Expanded).* | | | | | | | | | | | | | | |
| Chinese | 26 8 | 26·3 | 27 | 27·8 | 29·3 | 30·3 | 30·8 | 31·4 | 31·8 | 32·1 | 32·2 | 31·6 | 33·2 | 31·4 |
| *Neck (Circumference).* | | | | | | | | | | | | | | |
| Chinese | 10·3 | 10·4 | 11 | 11·2 | 11·8 | 12·2 | 12·5 | 12·7 | 13 | 13·2 | 13·1 | 13 | 13·3 | 12·9 |
| *Wrist (Circumference).* | | | | | | | | | | | | | | |
| Chinese | 4·8 | 4·6 | 5 | 5 | 5·3 | 5·4 | 5·6 | 5·7 | 5·6 | 5·7 | 5·7 | 5·7 | 5·8 | 5·7 |
| *Hips (Circumference).* | | | | | | | | | | | | | | |
| Chinese | 27·1 | 26 | 27 | 27·3 | 29·3 | 30·2 | 30·7 | 31·1 | 31·7 | 32 | 32 | 31·6 | 32·2 | 31·2 |

From the figures it will be seen that Chinese boys, though lighter in weight, are taller than English boys up to the age of sixteen. After that the stature of the English boy increases much more rapidly than that of the Chinese boy. Mr. Crook thinks that this important difference is due to the fact that the Chinese boy takes much less exercise than the English boy after the critical age. It may be partly due to that, but it is highly probable that the greater part of the difference is racial. Mr. Crook remarks on the small amount of chest expansion of the Chinese, but the 2 inches which he usually obtains is little, if any, short of English and French normals. Mr. Crook's measurements are of considerable value, and it is much to be desired that Englishmen residing among little-known races should imitate his example.

## MOSQUITOES AND PEAT.

The likes and dislikes of mosquitoes are so multifarious that one may never be surprised at anything in their bionomics. Some prefer to live in their larval stages at the edge of weedy pools and rivers, some in clear pools, others in such artificial collections of water as are to be found in old sardine tins, calabashes, cisterns, rain-water barrels, and tanks on board steamers, even the liquid in the pitcher plants forms a breeding ground, and yet others occur in the water held up in cut and insect-damaged bamboos. Each species seems to have its own particular place to live.

A recent letter in the *Times* refers to the absence of mosquitoes in swamps and marshes with peat. The writer, "Many Lands," says:—"Given marshy lands and no peat mosquitoes abound, given marshy land and peat there are none." This may be true where the writer has been, and in many other places, but it is not a universal rule. It must certainly depend on what species the mosquitoes are, for we have found such as *Anopheles nigripes*, Staeg., and *Anopheles bifurcatus*, Linn., breeding in the water of peat cuttings in Wales and Somerset, and on the far-famed Wicken Fen numbers of *Culex cantans*, Meigen, in the waters there. Mosquitoes are often very abundant in the fens, even where the peat is dug. Besides these, we have found *Anopheles maculipennis*, Meig., and *Theobaldia annulata*, Meig., in peaty water and near peat piles in North Wales. In America Smith records that the mosquito larvæ are few where sphagnum swamps abound, and we may find that peat areas are similarly not favourable to certain mosquitoes. Nothing definite is known of this subject. It would not be waste of time to try if a few blocks of peat thrown into a pool or artificial collection of water would destroy the larvæ, but from what we have seen of at least five of our twenty-two British Culicidæ it seems doubtful if it would do so.

Towards the end of the letter in the *Times* the writer says, "for of course mosquitoes cannot breed in salt water."

This statement is quite incorrect, for many do so. Take Australia alone, and we find three species breeding in salt water, namely, *Mucidus alternans*, Westwood, *Culex vigilax*, Skuse, and *Nyssorhynchus annulipes*, Walker. In Malta we get *Acartomyia zammitii*, Theobald, in Italy *Culex salinus*, Ficalbi, living in salt water, and others could be mentioned. It would be as inaccurate to say that mosquitoes cannot breed in water on marshy land with peat as it is to say they cannot breed in salt water.

Fred. V. Theobald.

## NOTES.

It is announced that Sir Daniel Morris, K.C.M.G., Imperial Commissioner, West Indian Agricultural Department, has resigned his post, which he has occupied with conspicuous success during the past ten years.

It is estimated by an officer of the American Department of Agriculture that the recent forest fires in the United States have caused losses at the rate of a million dollars a day. In New York State alone 44,935 acres were destroyed by the flames by the end of September. The Forestry Bureau at Washington has issued a statement declaring that probably in every instance the fires might have been prevented if the States had provided an adequate number of men to patrol the woods and stop the fires at their beginning, and if lumbermen and others who use the forests had been careful to dispose of brushwood after logging.

The first International Road Congress was opened at Paris on Monday at the Sorbonne, Paris, under the presidency of M. Léthier, Inspector-General of Bridges and Roads. More than two thousand delegates, representing twenty-nine countries, are attending the congress. Among the groups of subjects to be discussed are:—construction and maintenance of roads; general methods of maintenance; wear and dust; traffic and its working; effect of new methods of locomotion upon the roads; the effect of the roads upon vehicles; signals upon the road; roads and services of mechanical transport.

The winter lectures at the London Institution, Finsbury Circus, London, E.C., will begin on October 26, and continue until the end of February, 1909, two lectures being delivered each week. The programme arranged is of a varied character. Among the lectures we notice the following:—excavations in Memphis, by Prof. W. M. Flinders Petrie, F.R.S.; underground water supply, by Mr. C. Carus-Wilson; sea-urchins and the relation between the individual and its environment, by Dr. J. W. Jenkinson; Mendelian heredity, by Mr. William Bateson, F.R.S.; and the use of oxygen: demonstration of life-saving apparatus for use in mines and submarines, by Mr. Leonard E. Hill, F.R.S.

The bison range in the Flathead Indian Reservation in Montana, to establish which the United States Congress at its last session appropriated 8000*l*., has been selected. We learn from *Science* that the range is the one recommended by Prof. Morton J. Elrod, of the University of Montana, after he had examined carefully several parts of the country. It lies directly north of the Jocko River near the towns of Ravalli and Jocko. Approximately 12,800 acres are embraced in the tract, which will be fenced in a substantial manner. Of the amount appropriated, only 2000*l*. will be available for fencing the range and constructing the shelter sheds and other buildings necessary for the proper maintenance and care of the bison. The remaining 6000*l*. will be paid to the owners of the land, many of whom are Indians. Funds for the purchase of bison are being raised under the auspices of the American Bison Society, which was largely instrumental in securing the grant.

On October 10, in the presence of the leading aëronautical experts of France, Mr. Wilbur Wright, with M. Painlevé as a passenger, accomplished a flight of 1h. 9m. 45·6s. in duration, the distance covered being estimated at nearly seventy kilometres. This successful flight is the last demanded of Mr. Wright by the French syndicate which has acquired the local rights in his aëroplane by the payment of 10,000*l*. at once and 10,000*l*. in a month's time, after three men have been trained to work the machine. The *Daily Mail* states that on November 1 the Société navale des Chantiers de France will begin at Dunkirk the construction of fifty Wright aëroplanes, which are to be sold at the price of 1000*l*. each. The Aéro Club of France has decided to award to the brothers Orville and Wilbur Wright its grand gold medal for the year 1908.

The Committee on Ancient Earthworks and Fortified Enclosures, under the chairmanship of Lord Belcarres, has during the past year lost the services of two men who contributed largely to the conservation of these important remains—Mr. I. Chalkley Gould and Sir John Evans. It is satisfactory to learn that Maiden Castle, near Dorchester, has been transferred to the care of the Commissioners of Works; and that mounds at Thetford Castle, in Norfolk, and Waytemore, near Bishop's Stortford, have been taken over by the local authorities. So far only the county councils of Hertfordshire, Leicestershire, London, Staffordshire, the West Riding of York, Galway, and Louth have exercised the powers conferred by the Ancient Monuments Act of 1900. Meanwhile Scotland and Wales have succeeded in procuring the appointment of Royal Commissions to compile an inventory of their local antiquities. It is high time that antiquaries in England pressed for a similar measure, and for the appointment of an Inspector of Ancient Monuments, particularly as much recent damage is reported from various parts of the country. The report of the committee gives interesting details of excavations in progress, and notes some cases in which measures have been taken to check that spirit of vandalism which is now happily decreasing under the watchful care of the local archæological societies.

The first meeting of the council of the International Electrotechnical Commission is to be opened by Mr. Balfour on October 19 at the new rooms of the Institution of Electrical Engineers, Victoria Embankment. The commission originated through resolutions of the Government delegates to the St. Louis Electrical Congress in 1904, when it was decided that steps should be taken to secure the cooperation of the technical societies of the world by the appointment of a representative commission to consider the question of the standardisation of the nomenclature and ratings of electrical apparatus and machinery. A preliminary meeting of the International Electrotechnical Commission was held in London in June, 1906, fourteen countries being represented. The chief question which will be discussed next week is that of nomenclature. The subcommittee on nomenclature, under Mr. A. P. Trotter, appointed by the British committee, has been at work during the past year trying to settle the best explanations for the terms in general use in the electrical industry, and has drawn up a preliminary list. The suggestions put forward by the French committee for a provisional standard of light are to be considered, and the subject of the metric system as affecting the work of the commission is also to be discussed.

The International Conference on Electrical Units and Standards, the constitution and objects of which were described in last week's Nature, was opened on Monday at the rooms of the Royal Society by Mr. Churchill, M.P., president of the Board of Trade. In the course of his remarks at the opening of the proceedings Mr. Churchill said:—"Fourteen years have passed since the last International Congress, at which definite resolutions were passed as to electric units. The resolutions of Chicago in 1893, based as they were upon the conclusions reached at Edinburgh in the previous year, have formed the starting point of legislation in various countries. The present conference owes its inception to the resolution agreed to by the delegates of many countries four years ago at the great exhibition at St. Louis. That resolution not only confirmed the necessity for a more practical and perfect uniformity of electrical standards through the labours of an international commission, but further expressed the hope that that commission might ultimately be preserved in a permanent form. His Majesty's Government has responded with precision and cordiality to the proposal to convoke an international conference in London. The result of the invitations has been most gratifying. The importance of the work is undoubted, the capacity of the conference is indisputable. It is not within the scope of such a conference to formulate laws for Governments and nations. It is its business to define in clear and accurate expression those scientific quantities in terms of which electric energy is bought and sold, and, if possible, to embody its conclusions in draft articles which may form the basis of legislation and administration, so far as electric units and standards are concerned. While the work of the conference is scientific, it must also be practical. It is of the greatest interest to science to realise, in the most exact manner, the fundamental units of the electrician; but the primary work of the conference is to define and specify standards for the purposes of trade and commerce. Those standards must be definitely fixed in value; they must be permanent, and they must be reproducible. Physicists will continue their researches into the exact relations of those standards to the fundamental units, and each year will make the knowledge of those relations more complete; but the object of the conference is to secure the immense advantage to trade and commerce, by establishing a universal system of standards acceptable to all." After a vote of thanks had been passed to Mr. Churchill, Lord Rayleigh took the chair, and the business of the conference commenced. In the evening the delegates were entertained at dinner by the president and members of the Royal Society Club, and a reception was held by Lord Rayleigh and the council of the Royal Society. As at present arranged, the last meeting of the conference will be held on Wednesday, October 21, and we hope to publish an account of the proceedings in Nature of the following week.

*Naturen* for September contains the conclusion of Dr. L. Stejneger's article on the relations of the fauna and flora of western Norway. Reference is made to the distribution of certain liver-worts and to the bearing of the newly described *Microtus arvalis exsul* of the Hebrides on the theory of a former land-connection between Scandinavia and Scotland.

Insects injurious to local crops in 1907 form the subject of Bulletin No. 251 of the Michigan State Agricultural Experiment Station. Among these, the most harmful appears to be the so-called rose-chafer, which visits many of the vineyards in millions. It is noted that certain evil-smelling bugs prey upon the potato-beetle.

Some time ago Dr. F. A. Bather attempted a revision of the nomenclature of the crinoids. The subject has been further elaborated by Mr. A. H. Clark in a paper published as No. 1623 of the Proceedings of the U.S. National Museum. Dr. Bather's conclusions with regard to the names to be used are stated to be incorrect, except in the case of two genera.

No. 4 of vol. v. of the University of Colorado Studies includes a list of Colorado Entomostraca, by Mr. G. S. Dodds. The list is not a long one, but this is probably to a great extent owing to imperfect knowledge, and when collections have been made from the numerous small lakes at elevations between 6000 feet and 1200 feet, it is probable that the number of these organisms will be very largely increased.

We have received a copy of a second edition of a guide to the Wilberforce Museum at Hull, in which Mr. T. Sheppard gives much interesting information with regard to William Wilberforce and his connection with that city, which was his birthplace. In addition to Wilberforce relics, the building also contains objects connected with the history and trade of Hull, among the latter being a complete collection of whaling implements.

In a paper on the Ceylon fishery of window-pane oysters (*Placuna placenta*), published in the August number of *Spolia Zeylanica*, Mr. A. Willey describes a certain very remarkable peculiarity in the development of that species. The fact that the largest oysters examined during the inspection in October last were immature leads to the conclusion that Placuna does not produce an annual brood, but that one generation succeeds another at intervals longer than one year, and that sexual maturity is attained only after completion of the superficial growth of the shell, the life of individual oysters probably being three years.

In the September number of the *Zoologist* Mr. H. E. Forrest directs attention to the remarkable difference between the vertebrate faunas of Wales and Ireland, dwelling specially on the absence from the island of moles, short-tailed field-mice, weasels, polecats, reptiles, and several kinds of fresh-water fishes. In explanation it is suggested that the paucity of the Irish fauna may be due to that island having become separated from Great Britain before the latter was cut off from the Continent by the English Channel. The theory of a direct connection between Ireland, Scotland, and western Norway is ignored.

In an article on wild life in the Murray Swamps, published in the August number of the *Victorian Naturalist*, Mr. A. H. E. Mattingley utters yet another protest against the evil deeds of the plumage-hunters. "Dead and dying egrets," he reports of a certain spot, "were everywhere. The plume-hunters had been there before me, and the wreck they had left behind made my blood boil with indignation. It would not have been so bad had the slaughter consisted only of the hundred or so of adult birds, but, as these were the parents of three times as many fledgelings, left to die of starvation, you may readily guess how I felt."

We have been favoured with a copy of the first number of a new work entitled "Wild Beasts of the World," by Mr. F. Finn, published by Messrs. T. C. and E. C. Jack. The work is to be completed in seventeen parts, at the price of 1s. each, and is to be illustrated by 100 coloured quarto plates, six of which are issued in the part now before us. These, which represent apes and monkeys, are executed in the three-colour process. In the text Mr. Finn relates a fact previously unknown to us, namely, that Kirk's guereza monkey, of Zanzibar, has been exterminated by natives sent by Sir John Kirk himself to ascertain how many individuals survived.

Some time ago Prof. Prowazek described certain bodies discovered by him in the intestine of the lizard as the reproductive cysts of *Bodo lacertae*, a parasitic flagellate found in the same situation. It was further stated that these "cysts" underwent a unique kind of "autogamic" development, the details of which it will be unnecessary to discuss. At a later date Mr. C. C. Dobell discovered in the intestine of the frog, associated with parasites known as *Octomitus ranae* (which are apparently near relatives of Bodo), very similar bodies. These he very naturally regarded in the same light as those described by Prof. Prowazek, but fresh investigations have caused him (as narrated in *Biologisches Centralblatt* for September 1) to come to a very different conclusion. He now decides that the "cysts" in the frog's intestines are yeasts, and suggests that the bodies described by Prof. Prowazek from the lizard are of a similar nature. If this be so, the "autogamous" reproduction of Bodo is a myth.

In order to obtain a better knowledge of the *rôle* of birds in the economy of nature, a novel kind of ornithological survey was undertaken a year ago in Illinois, a couple of observers in summer marching at a distance of thirty yards apart over long strips of three different districts, and noting the number of birds of each species seen. The total number of birds observed per square mile was 645, or almost exactly one per acre, but by eliminating 1414 interloping European sparrows, the number of native birds was found to be 527 to the square mile. The total number of native birds on this basis for the whole of Illinois works out at 30,750,000, in addition to which are 5,536,000 sparrows. Of the eighty-five species represented by the 7740 birds recognised on the trips, the twenty-one most common species accounted for no less than 6596; in other words, 85 per cent. of the birds belonged to 25 per cent. of the species. It is these abundant species that are alone to be considered in the effects of bird-life on the products of the country.

In a paper published in vol. xxxiv. (pp. 393–402) of the Proceedings of the U.S. National Museum, Mr. M. W. Lyon expresses his opinion that the placing of the American prong-buck (Antilocapra) in a family by itself is not justified by the facts. Its only essential difference from the Bovidæ is to be found in the forking and annual shedding of the horns, and the consequent absence of annual rings of growth at their bases. In addition to these characteristics may, however, be mentioned the large number of cutaneous glands (namely, a pair behind the lower jaw, another pair on the ischium, two interdigital pairs, a pair on the hocks, and a single one on the hind part of the back in advance of the rump-patch) in this ruminant. The species should be regarded as representing a subfamily (Antilocaprinæ) of the Bovidæ.

During the last twenty years of his life, the late Mr. C. B. Clarke became the recognised authority on the Cyperaceæ, and received species for identification from all parts of the world, whereby he accumulated material for a prospective monograph of the order. On account of its great length the preparation of the work for publication is not at present possible, but the director of Kew Gardens has assigned the eighth volume of the additional series to the Kew Bulletin to the publication of his descriptions of unrecorded determinations. There is also included an enumeration of all the species in his manuscript ordered according to his proposed classification under generic subdivisions.

We have been favoured with a copy of the paper, by Mr. F. A. Stockdale, on the fungus diseases of cacao, published in the *West Indian Bulletin* (vol. ix., No. 2). Stem canker and root disease have been chiefly responsible for destruction of trees in the West Indies, but "die-back" of branches caused by *Diplodia cacaoïcola* and a pink disease connected with a Corticium have been troublesome in St. Lucia, and recent investigations in Trinidad point to the ravages of a species of Lasiodiplodia. The pods are liable to be rusted by the Diplodia mentioned, or may be infested by *Phytophthora omnivora*, which produces a black rot. Altogether a formidable list of pests is recorded, but, fortunately, most are amenable to treatment, whether this consists in improving the vigour of the trees by tillage or manuring, or in spraying with or without the application of the excising knife.

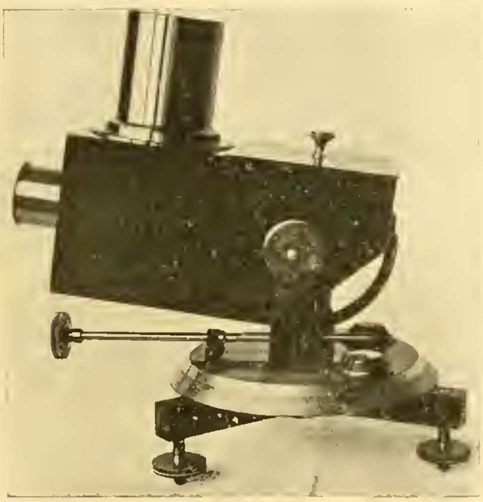
There are no stages in the life-history of phanerogams more widely and correctly known than the normal divisions of the nuclei in the embryo-sac or megaspore; the stages at which the "reduction-divisions" take place are not, however, so accurately known. In the *Botanical Gazette* (June) Prof. J. M. Coulter discusses the interpretation of irregular nuclear and cell divisions occurring at these stages. He points out that ordinarily five successive divisions occur from the megaspore mother cell to the fertilisation stage, and observes that the two reduction divisions are essential. In Lilium there are only three divisions, of which two should be regarded as reduction divisions forming megaspore nuclei. All these nuclei enter into the structure of the female gametophyte, and there is one subsequent division. Peperomia and the Penæaceæ afford difficulties of another kind, but here there has been, in the author's opinion, no additional division of the free nuclei.

The meteorological year-book of the Bremen Observatory for 1907, published by Dr. P. Bergholz, contains complete hourly observations from automatic instruments with results, and rainfall values for several stations in the neighbourhood. A special feature is made of phenological phenomena; the results are given for the year in question, with means for the years 1896–1907. The work forms one of the excellent year books of the German Empire, and is the eighteenth volume of the Bremen series.

Mauritius in 1850 was covered with forests to the extent of about one-third of its area. In 1880 this had been diminished to about one-tenth of the area of the island, and, of course, some of this has been cleared since. In view of the opinions expressed by Mr. Thompson in 1880 and Mr. Gleadow in 1904, that the destruction of the forests had an adverse influence on the climate of the island, Mr. A. Walter, chief assistant of the Royal Alfred Observatory, has made a thorough examination of the data available in order to find some statistical evidence either for or against these opinions ("On the Influence of Forests on Rainfall and the Probable Effect of 'Deboisement' on Agriculture in Mauritius"). Mr. Walter finds in the smoothed rainfall curves extending over the period 1860 to 1907 evidence that the cutting of the forests may have had some little effect on the total fall, but has had more effect on the number of rainy days. The distribution through the year is almost more important than the amount. The rainy days in the districts denuded of forests have been decreased by about

30 days per year, but under such conditions that the amount due to these 30 days is only about 6 to 10 inches, whereas the annual variation of total rainfall is often 60 inches. Before the forests were cut rain fell on many calm afternoons, because the presence of moisture transpired by the trees was sufficient by increasing the humidity and decreasing the pressure to cause slight showers. The rain caused in this way is, however, very local, and apparently Mr. Walter does not recommend any great work and expense in planting trees with the idea of improving the climate generally.

THE exact knowledge of the speed at which the clouds travel is one of the best means of ascertaining the presence, direction, and velocity of certain currents of the upper atmosphere which directly affect aërial navigation. The accompanying illustration shows an instrument designed for this purpose, and manufactured by Richard, of Paris. The apparatus is mounted on a horizontal axis around which it may be turned by means of a long screw. The two supports on which it rests are fixed over a divided brass disc, which may be turned horizontally around an axis placed on a support fitted with three adjustable screws.



The Nephoscope.

Inside the apparatus are two mirrors placed relatively at an angle of 45° in the direction of a spy-hole, through which the operator looks, and towards a reticle consisting of a four-sided piece of glass placed in such a way that the distance between two lines represents the angular space of a degree. The reticle is placed in a tube holding a special system of lenses arranged in such a way that the face of the reticle is reflected in the mirror. It thus happens that on looking through the spy-hole the face of the reticle is seen projected upon the cloud under observation. It is necessary to observe the movement of the cloud and to know its altitude in order to determine the speed at which it is travelling. Two such instruments placed at a known distance apart and observing the same cloud would give the height, and, at the same time, two measurements of the velocity. The mounting of the apparatus on two axes, one vertical and the other horizontal, allows it to be placed at any angle, so that the sky may be explored in every direction.

THE August Bulletin of the Bureau of Standards at Washington contains a paper of 132 pages on the various formulæ for the calculation of the self and mutual inductances of coils, by Messrs. E. B. Rosa and L. Cohen. The authors have included all the formulæ which have been found correct, and indicate the conditions under which one or other is to be preferred. The numerical work is carried out in a number of cases in order to show the application of the formulæ, and more than twenty pages of tables to facilitate the calculations are given.

ACCORDING to a communication made to the Versammlung deutscher Naturforscher und Aerzte at the recent meeting at Cologne, Prof. H. W. Schmidt and Dr. P. Cermak, of Giessen, have discovered the cause of the different results which have been obtained in experiments to determine the effect of high temperatures on the radioactive properties of substances. They find that if the experiment is made with the radio-active material in a new quartz tube, change of temperature appears to have no effect on the activity of the substance, and that the apparent effect obtained with an old tube is due to the diffusion into and through the material of the tube of the products of decomposition—radium B and C. Although the authors have not yet completed their experiments, they consider they have sufficient evidence to justify the statement that for changes of temperature up to 1500° C. no change of the radio-active properties of substances can be detected by the most sensitive instruments.

IT is a well-known fact that when a saturated vapour below its critical temperature has its volume suddenly decreased, some of the vapour is condensed on the walls of the containing vessel, and, in running down them, gives the appearance of ripples. In the *Physical Review* for August, Messrs. W. P. Bradley, A. W. Browne, and C. F. Hale, of the Wesleyan University, Middletown, Connecticut, show that the phenomenon of ripples is also exhibited when the same experiment is carried out with vapour above the critical temperature. They consider that this observation supports the theory that at and above the critical temperature the miscibility of liquid and vapour is unlimited, while below it is limited by the existence of a saturation point. On this view the "area of liquefaction" of the Andrews diagram is really the "area of saturation"; outside it on the side of large volumes liquid may exist, but not in sufficient quantity to saturate the vapour, while outside for small volumes vapour may exist, but not in sufficient quantity to saturate the liquid.

INCREASED importance is year by year attached in our elementary schools to simple instruction in the elementary rules of healthy living. Many easy reading books have been produced to assist teachers in this direction, and among these is Mr. W. Taylor's "First Reader in Health and Temperance," a new edition of which has just been issued by Messrs. George Philip and Son, Ltd., and the Church of England Temperance Society.

A USEFUL catalogue dealing with apparatus suitable for chemical lecture experiments and various forms of lecture lanterns has been received from Messrs. A. Gallenkamp and Co., Ltd. It includes particulars of all the equipment necessary for the performance of the experiments described in the better-known books dealing with chemical lecture demonstrations. In addition to the illustrations and particulars as to the sizes and prices of the instruments, the catalogue provides many hints to teachers as to the way the apparatus should be used and the purposes to which it may be put. The list also contains information concerning the supply of compressed oxygen, and particulars respecting liquid air and the apparatus employed in handling it.

ON previous occasions we have referred in terms of praise to special catalogues, like that of books on the useful arts, prepared by Mr. Basil Anderton, the public librarian, and published by the Newcastle-upon-Tyne Public Libraries Committee. We have now received a copy of the new catalogue, edited by Mr. Anderton, of the Newcastle-upon-Tyne Central Lending Library, which includes all books in circulation except English fiction, children's books, and books for the blind. The volume consists of 712 pages of large size, and is, in the main, an author catalogue arranged in the alphabetical order of authors' names and writings. A noticeable feature is the introduction, under an author's works, of particulars of books by other writers containing scientific, philosophical, or other criticisms of them. It is satisfactory to find that scientific works occupy a prominent place in the library. The readers of Newcastle-upon-Tyne may be congratulated on the possession of a complete and well-arranged guide to the large number of books at their disposal.

## OUR ASTRONOMICAL COLUMN.

A NEW SATURNIAN RING.—A telegram received at the Kiel Centralstelle on October 8 announces that a new, dusky ring surrounding the bright rings of Saturn has been discovered at the Geneva Observatory (Kiel Circular, No. 104).

COMET MOREHOUSE, 1908*c*.—Numerous observations of Morehouse's comet, 1908*c*, are recorded in No. 4275 of the *Astronomische Nachrichten* (p. 46, October 5).

Some suggestion of change, which may be due to observing conditions, appears in the observations of Prof. E. Millosevich and Dr. Zappa at Rome between September 12 and 17. On the former date the brightness of the comet appeared to be less than at a previous observation, made on September 4, and a tail was suspected extending a little to the west of south. On September 14 the coma showed a nucleus of magnitude 10·5, and the tail extended to a distance of 11′ in position-angle 217°. Both coma and tail exhibited an increase of splendour on September 15, the latter extending for some 14′ to 15′. On September 16 the coma and nucleus were again brighter, but the tail, in position-angle 228°, was not so well seen; with a clear, moonless sky on the following day this note was confirmed, and the tail was seen to be curved with its convex side towards the east, the position-angle of the tangent at the commencement of the tail being 204°.

At the Moscow Observatory, on September 17, M. P. Sternberg found the comet's head to be about 45″ in diameter, and to contain a condensation which exhibited a granular structure. A photograph obtained by Dr. Kostinsky, on September 19, with the 13-inch astrographic telescope, exposure 44m., showed a short fan-like tail extending towards the south; the magnitude of the whole comet was estimated as 8·0.

In the *Comptes rendus* for October 5 M. Bigourdan reports striking changes in the comet's tail. On September 29 it was regular and 20′ in length, but on the succeeding night it was irregularly fainter, showing bright patches. At 10h. 24m. on October 1, however, no tail was to be seen, although it was detected again, some 4′ or 5′ in length, on October 3. All the observations were made with the same instrument.

A new set of elements, by Prof. Kobold, appears in the *Astronomische Nachrichten*, and Prof. Dale has also computed new elements and an ephemeris, which is given below:—

*Ephemeris, for Greenwich Midnight.*

| 1908 | R.A. h. m. | Dec. N. ° | log $r$ | log $\Delta$ | Brightness |
|---|---|---|---|---|---|
| Oct. 16 | 19 23·5 | 48 1·7 | 0·1778 | 0·0107 | 5·4 |
| ,, 18 | 19 17·9 | 44 27·8 | 0·1707 | 0·0121 | 5·5 |
| ,, 20 | 19 13·3 | 40 55·4 | 0·1635 | 0·0151 | 5·7 |
| ,, 22 | 19 9·4 | 37 26·8 | 0·1562 | 0·0194 | 5·7 |
| ,, 24 | 19 6·1 | 34 2·8 | 0·1489 | 0·0255 | 5·8 |
| ,, 26 | 19 3·3 | 30 46·0 | 0·1415 | 0·0332 | 5·8 |
| ,, 28 | 19 1·0 | 27 36·5 | 0·1341 | 0·0412 | 5·8 |
| ,, 30 | 18 59·0 | 24 34·3 | 0·1264 | 0·0495 | 5·7 |

Observations made at South Kensington on October 10 showed that Prof. Dale's positions are very nearly correct.

PHOTOMETRIC OBSERVATIONS OF VARIABLE STARS.—In No. 4275 of the *Astronomische Nachrichten* (p. 33), Herr A. Tass places on record the results of a number of photometric observations of variable stars. The observations were made at the O'Gyalla Observatory during the years 1905, 1906, and 1907.

A BOLIDE WITH A PERSISTENT TRAIL.—A number of drawings and a description of the trail of a bolide, observed by M. Quénisset, at Juvisy, on July 31, appear in the October number of the *Bulletin de la Société astronomique de France*. The bolide itself appeared at 11h. 12m., and was sufficiently bright to illuminate the surrounding scenery for about half a second, as though the moon were shining. The trail left by the bolide was visible in a binocular twenty minutes after the apparition, and could be seen with the naked eye for half that time. At first a straight line, the trail afterwards curved up at both ends until finally it became an elliptical nebulous cloud, very like a telescopic comet. During these transformations the whole cloud was displaced, gradually but regularly, in a W.N.W. to E.S.E. direction. When the first drawing was made, the trail was situated about 1° north of, and parallel to, the line joining $\alpha$ and $\beta$ Aquarii, the coordinates of its commencement and end being, approximately, 335°, +3°, and 320°, −5½°, respectively.

RADIAL VELOCITY OF ALGOL.—From measurements of the spectrograms taken at the Pulkowa Observatory during 1905–7, Prof. Belopolsky has derived a set of elements for the orbit of Algol, and publishes it, together with a detailed account of the reduction, in No. 22, vol. xi. (1908), of the *Mitteilungen der Nikolai-Hauptsternwarte zu Pulkowo*. Each of the lines Hδ, Hγ, λ4472 (Hε), λ4481 (Mg) and Hβ is discussed separately, and the following elements result from the complete discussion:—

| | |
|---|---|
| $\omega = 42^\circ{\cdot}5 \pm 1^\circ{\cdot}35$ | $a = 1{,}693{,}523 \pm 100$ km. |
| $e = 0{\cdot}0476 \pm 0{\cdot}0037$ | $i = 90^\circ$ |
| $T = 2{\cdot}509 \pm 0{\cdot}00019$ days | |

THE EFFECT OF STAR-COLOURS UPON THE CONSTANT OF ASTRONOMICAL REFRACTIONS.—To determine the effect of the colour of the star observed upon the constant of refraction, Mr. Hirayama, of the Tokio Observatory, reduced the observations of Courvoisier, Bauschinger, and Nyrén by dividing their stars into three groups, according to colour, and then deriving the corrections to the assumed value of the constant corresponding to the different colours. The results of the discussion are published by the Tokio Mathematical Society, as a reprint from No. 17, vol. iv. (second series), of the *Tôkyô Sûgaku-Buturigakkwai Kizi*, and show (1) that the effect of the colour of the star upon the constant of refraction is not shown in any single series, (2) the arithmetical mean of the three series to be 60″·19 for whitish-yellow stars, 60″·16 for yellow stars, and 60″·12 for reddish-yellow stars.

HALLEY'S COMET.—Prof. Turner's discourse on Halley's comet, given at the recent British Association meeting, has been published by the Clarendon Press at the price of 1*s*. net. After some general, personal, and historical notes, Prof. Turner describes the several circumstances which led to Halley's sagacious conclusion respecting the periodicity of comets, and then proceeds to describe briefly the conditions under which the coming reappearance of Halley's comet will probably take place. According to the ephemeris prepared by Messrs. Cowell and Crommelin, the comet should enter Pisces, from Aries, in January, 1910, travel westwards towards $\gamma$ Piscium until the beginning of May, and then, turning eastwards again, travel back through the constellations Cetus, Orion, Monoceros, Hydra, and Sextans. From this it will be seen that observers in the southern hemisphere will be better situated for seeing the comet, and, as Prof. Turner points out, it is just possible that it will be well seen in Tasmania during the total solar eclipse of May 8, 1910. The computed brightness varies from 1·0 on January 2 to 58 on May 2, to 1112·0 on May 10, and afterwards decreases to 8·6 on May 30, 1910.

## CAMBRIDGE UNIVERSITY APPEAL FUND.

ON February 16, 1907, the late Duke of Devonshire, my predecessor in the Chancellorship of the University of Cambridge, was through your courtesy enabled to make a statement dealing with the needs of the University, and to give some account of the efforts made by the Cambridge University Association to obtain funds to increase the endowments of the University. The interest taken by him in the association and its work is well known, and on succeeding to the Chancellorship I have accepted the invitation of the association to become its president. I therefore beg that you will now allow me to renew his appeal to all those interested in the promotion of higher education, learning, and research.

The fact that the majority of recent donors have been Cambridge men encourages me to hope that there may be many others amongst our graduates who will help us according to their ability. Others of our most munificent benefactors have not been themselves members of the University, and I would further appeal to all interested in the advancement of learning to enable the ancient University of Cambridge to continue the development of its sphere of usefulness. I believe that all acquainted with what has been done at Cambridge in recent years will agree that, to the extent of the resources available, progress has been satisfactory and in some departments remarkable.

In the letter which you published on February 21, 1907, my predecessor estimated the needs of the University at nearly a million and a half. Since the financial position of the University was first made known, legacies for specific objects have been received to the amount of upwards of 100,000*l*. The late Vice-Chancellor in his valedictory address to the Senate gratefully acknowledged the continued liberality of the Goldsmiths' Company, as well as substantial donations from the Surveyors' Institute and the Clothworkers' Company. The munificence of the City Companies and the generosity of many private donors have thus enabled the association to transfer to the University sums amounting to about 139,000*l*. The Drapers' Company are giving 1000*l*. a year to the funds of the agricultural department. A further annual grant of 100*l*. for six years for economics is being given by the Girdlers' Company. Since the establishment of the association, the University has thus benefited to an amount of more than 250,000*l*.

A small committee of Cambridge men has recently been formed in London with the object of assisting the association in its efforts. The establishment of this committee was approved by the late Chancellor shortly before his death, and his nephew, the present Duke of Devonshire, has consented to act as its vice-chairman. This committee proposes to direct its attention to specific objects which may appear from time to time to be the most urgently in need of support. At the present moment the completion of the fund for building, equipping, and maintaining the laboratories of the school of agriculture is one such object, and we are indebted to the Duke for taking charge of this appeal, in which his uncle, the late Chancellor, had shown much interest. For this purpose 5000*l*. at least is still required.

It is not advisable to enter here into details as to the various directions in which further endowments of the University are urgently needed, but the Vice-Chancellor will be glad to furnish specific information. For the moment I will confine myself to indicating the projects which are engaging the immediate attention of the association and of the London committee. They are:—

(1) The completion of the fund for the school of agriculture.

(2) The completion of the fund for building the new museum of archæology and ethnology.

(3) The adequate endowment of modern languages.

With respect to this last requirement, I may explain that the mediæval and modern languages tripos, established in 1884, has recently been re-modelled on broader and more practical lines, and that it now includes English, French, German, Spanish, Italian, and Russian. The teaching in these languages is vigorously carried on. Readerships in the Romance and Teutonic languages exist; but there are in the University no professorships of French or German, or indeed of any other modern European language.

In conclusion, I beg leave to say that donations may be sent to me, or more conveniently, as I expect to be away from home for about six months, to Mr. E. H. Parker, the hon. treasurer of the Cambridge University Association, Barclay's Bank, Cambridge. RAYLEIGH.

Terling Place, Witham, Essex, October 5.

## THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY.

THE distribution of prizes and medals to students of the Imperial College of Science and Technology by Sir William White, K.C.B., on October 7, may to some extent be regarded as the inaugural meeting of the college, since it was the first function of its kind at which the new rector, Dr. Henry T. Bovey, F.R.S., was present. In his remarks from the chair, Sir William White gave some particulars as to the work which has been accomplished by the governing body. He explained the objects of the new college, and said that a start has been made with existing institutions, but that branches of science and technology unrepresented in these institutions are to be added to the subjects in which instruction will be provided by the new college. Any higher instruction in technology which is provided in provincial institutions will, he said, be utilised, and every effort made to build up a great college capable of conferring advantages both upon the home country and the whole of the Empire. Referring to the appointment of the new rector, Sir William White remarked that in appointing Dr. Bovey the governing body has secured a man whose qualifications and experience represent in the happiest manner the imperial idea which will inspire the future work of the college. In conclusion, the chairman announced that it is hoped that in future years the honours gained by the students in each of the institutions included in the Imperial College will be presented at the same ceremony.

After the prizes and medals had been distributed the rector delivered his address, which is here published in full. At the conclusion of his address, Dr. Bovey announced the provision of the equipment of the mining and metallurgy laboratories in the new buildings, the plans of which have been prepared by Sir Aston Webb, and the erection of which will be begun in the near future; the gift by Mr. Charles Hawksley of 4000*l*. for the equipment and endowment of an hydraulic laboratory in memory of his father; the equipment and endowment of electrical engineering laboratories at the college in memory of Lord Kelvin—a project which has met with the hearty approval of the King; and many valuable donations for the college library and museum. A vote of thanks to the rector for his inspiring address was proposed by Sir Norman Lockyer, K.C.B., who insisted that in all higher instruction in science and technology the great requisite is quality rather than quantity of work, and that the duty of an imperial college is not only the production of the skilled technologist but of men in the best sense of the term fully able to take their share in the work of the Empire.

### *Rectorial Address by Dr. Henry Bovey, F.R.S.*

We are met to-day as a section of the Imperial College of Science and Technology, a union of long-established and justly famed institutions. We are looking forward to a career the usefulness of which shall combine that of each of our component parts, and which will give to London another channel in which its force may be expressed as a whole. This is no light undertaking, and it would seem that the most appropriate subject on which I can speak to you to-day is that of our aims and ideals in this union, together with any suggestions which may occur to me as to the best means of carrying them out; and it may be well at the outset of our career, so to speak, if we should spend a few minutes in considering the advantages and disadvantages which are inseparable from our constitution.

I cannot doubt that in the Imperial College we shall find ourselves confronted with the same sort of problems as have beset other unions of all degrees of complexity, from family life to a United Germany or a United States—the problems, namely, which arise from the new mutual relations of the parts. In my opinion there is nothing to be gained and much to be lost if we do not frankly face these problems and see—yes, and foresee, so far as possible—the limitations, the responsibilities, the foundations, and perhaps the dangers of union.

In these days we do not need to be persuaded that union is strength, for it may be called the panacea of the age, and men fly to it as their only method of accomplishing every kind of object; but we do not so clearly see that a union is not necessarily strong in *direct* proportion to its numbers. The bridge-builder should not need to be reminded that there is a point beyond which length becomes a danger, yet we find in practice that there is still a temptation to make an engineering work the largest in the world—a temptation, in fact, to measure greatness by size. That we may be less likely to fall into this error, let us set before ourselves some ideals as to the quality of our union. I shall be forgiven, I am sure, if I seem to speak of the old and the obvious.

In any union of equals, if the members are to be loyal to the idea which has brought them together, they must remember that it is possible for selfishness to entrench itself in the care of one's particular and special department and in the ambition for its paramount influence, and that in this case, as in individual instances, he finds himself best who loses himself. This last resort of selfishness, as we may call it, not infrequently becomes apparent when there is a question of unequal advance. It is not unnatural that in such a case there should be a lurking sense of injustice, particularly if, as often happens, the new privileges fall to the share of the new departments and leave the old apparently unrecognised. The elder brother is not extinct even in the twentieth century. Yet, viewing the matter more largely, not only is it absolutely true that an increased advantage to, or an increased demand for, any special part increases the value and reputation of the whole, and therefore of all other parts, but if we think of it this is the usual method of growth in institutions which are not altogether the creation of Aladdin's lamp. Usually there is not enough of money to go all round at once, and we must be content if it goes around in time. In parenthesis, let it be taken for granted that it will be someone's duty to see that the time is not too long deferred.

*Next*, may I remind you that in a union of equals responsibility falls equally on all? How often do we hear it said, "*I* cannot help it, *they* would do it!" How often does a man rest content with not being an obstructionist, and never reflect that there is an active duty required from each person if the general good is to be achieved. What right has a man to sit down and let another do his share? It may be quite as bad to be indifferent as to be too anxious to lead. As to being an obstructionist, that is to put oneself outside the pale altogether—for it is to be a positive source of disunion. In order to secure wisdom as well as energy in the taking of personal responsibility, it will be well to think of the real foundations of union, which, for our present purpose, I may briefly put as:—first, a common object; second, a common method of obtaining it; third, a spirit of mutual respect and good-will.

The first and second will require in this instance a more lengthened discussion; the third we can count on in a convocation of educated and right-minded men, yet as the association is so close and the possibilities of clashing so many, it is well to keep it in mind as an essential.

Two dangers only I shall mention, opposite tendencies which, not seldom, are the fruitful sources of much evil. The first is the evil of courting popularity—of waiting to see which way popular opinion may lean. About this many things might be said which there is no time to say, but in general we may perhaps assume that the evil lies in shaping our course with any reference to the security of our own position, either in fact or in the esteem of others.

Then there is the reverse danger of being always in the opposition. It seems unlikely that every man who finds himself solitary should be an Elijah, and if he is like Elijah he should teach himself to recognise the 7000 like-minded.

Let us now consider a few suggestions as to our common object in the Imperial College and the best method of attaining to it. First, then, as to our object.

It may be well to think a little of our title as expressing our aims. Why do we separate science and technology in the title of this institution? Does it come from some feeling that technology is different from science, or that it is science *plus* something else? Some time ago I had occasion to study the relations of science and technology, and came to certain conclusions, which I may be allowed to give you without entering into the discussion of them.

Perhaps the most clear and concise definition I have come across of pure science is that it is "the knowledge of powers, causes, or laws considered apart or as pure from all applications." It involves the making of experiments, by which these laws have been made manifest. Compare this with the will of Count Rumford concerning the founding of a chair at Harvard in 1816 for teaching "the utility of the physical and mathematical sciences for the improvement of the useful arts." If we examine the curricula of the best modern schools of technology, we find advance has been made in this conception, and that they include:—

First, a study of selected laws of nature (*i.e.* those which have been or may be applied to practical purposes) (*a*) as seen in nature; (*b*) as seen in examples or descriptions of the means by which they have been utilised. This includes the study of all types of machinery, implements, and instruments.

Secondly, a distinct aim to train the mind of the student so as to develop what may be called the scientific mind; as yet this has been mainly attempted only by causing the student to study in a scientific manner.

Thirdly, (*a*) a research into the nature of the practical facts essential to any art with the view of finding out the known laws of nature on which they depend; (*b*) original research into the problems arising out of industrial processes with the view of finding out unknown laws of nature, and especially those which must be investigated on a large scale.

We see that technology, while in one department a pure science, investigating any problems arising out of the artificial working up of natural products, is in the main to be called an applied science—that its applications, even when exactly similar in outward appearance to the experiments called for by pure science, differ from the latter in one important particular. In the case of pure science the resulting fact is viewed as an instance of a law; in the case of technology, the fact itself is the important thing. Therefore the idea of utility seems to be the real key to the difference between the two—which seems to be a difference of aim. If our purpose is to establish a law we call it pure science; if our purpose is to establish a fact we call it applied science or technology.

Having thus more or less defined the difference between the two, we may say that our common object in the Imperial College is to give the right education in science and technology, and if we agree with the conclusions I have quoted we shall see that there should be great economy in combining the training in these two, the foundations being, in both cases, practically similar, and the only real difference coming from a wish to specialise either on the theoretical or on the practical side in one's professional life.

We may take it, in fact, that there will be less waste in the world's advance if the scientific man is influenced in his choice of his research by practical necessities, and if the practical man is influenced by pure science so as to be interested in and to recognise the light which may be shed on scientific relations by accidental or intentional changes of circumstances in the course of his work. There is no necessity in the nature of things that pure science should be absolutely lost in applied science. An education in the same place and under the same influences should therefore be desirable as giving opportunities for the increase of mutual knowledge and respect.

Our common object might be now a little more fully stated as the attempt to develop the ideal scientific and technical man. It is evident that the clearer our conception of what we want to produce, the more likely we are to attain *to* it. In reading and trying to harmonise the various ideals which have been brought before our notice by many distinguished writers and speakers, we are forced to the conclusion that no mere specialist can possibly fulfil modern requirements. Looking backward, we can see that formerly the scholar and the man of action were separated in idea and generally in fact. We can realise the change that has taken place, and can perceive that the ideally educated man of the world of to-day must possess, not only powers of thinking, but powers of doing, and must show that he has the will to do honest work both with and for his fellows.

One case occurs to me as confirmatory of this position as regards the mere specialist—the case of a man extremely successful in a line of life not originally chosen. Our hasty conclusion is usually that his first choice was bad, and bound to end in failure; but another quite possible explanation is that he does well in his second choice, just because, having possessed another point of view, he is more quick to grasp the possibility of those combinations which have characterised much of the advance in modern science.

I fancy there will be little disagreement as to the kind of man we want to produce, but when it comes to agreement on right methods we cannot hope to find unanimity of opinion. All we can expect to attain is a working hypothesis, and trust for the rest, first, to what is really the greatest factor in all true education, namely, the personality of the teacher, and next, and scarcely less, to the attitude of the student. Still, a working hypothesis must be embodied in every curriculum, and, to be really valuable, must be fixed enough to conform to the eternal laws of the mind and elastic enough to admit of constant translation into what we might call the scientific language of the moment.

Now that scientific training has acquired a foothold which justifies the existence of all the scientific and technical schools of the world, and the establishment here of a college such as we are contemplating, it can afford to spend a little time in adjusting its methods and examining its results.

What, then, is the general tendency of that which has been called a practical education in either science or technology, namely, an education intended to prepare a man for his life's work by direct methods only, as, for example, if we should try to train a man to be a mining engineer by giving instruction solely on those points which would be of immediate commercial value to him? I think, in comparing results, we must conclude that an education in facts, and even in laws and processes alone, cannot produce what we call the scientific mind. If we are to select the powers of the mind which are most essential to the scientific man, we shall find these generally admitted to be observation, concentration, imagination, the logical faculty, and last, but not least, the power of doing. No matter, then, how good an education may be, if these are not well developed it must be incomplete, and as the scientific man is, after all, first a man and then a man of science, nothing which leaves out of sight his intellectual relations with his fellow-men of this and other generations, nay, further, nothing which leaves out of sight his obligation to rule his life in accordance with the highest standards of health, of religion, and of morals, can fairly be called a good education. Viewed from this standpoint, the task set before itself by the Imperial College is by no means simple, but I think much may be done by throwing emphasis on processes rather than, or perhaps as well as, on results. It may be possible to give credit for evidence of the use of the powers that we seek to produce. For example, let us enter into some detail and see what this would involve. One would think, from most of what has been written on the subject of observation, that the power to observe, which does really seem to follow the system of training by experiment, was a power which, once gained, would necessarily be exerted in any direction; but, as a matter of fact, do we always find that a botanist, trained to observe, amongst other things, the colours of flowers, will always observe the colours, say, of ladies' dresses? Do we find that a geologist, who recognises every stone in his path, will always and at once recognise different types of men? It is interesting to note, in this connection, an experiment published in a recent book, from which it appeared that evidence taken from a large number of scientifically trained men showed a considerable number of cases in which important and even typical details were omitted.

Again, there the diffusiveness caused by the observation of unnecessary detail, which ought to be corrected by what is almost equally necessary to the student—the power of selection which is implied in concentration. No one needs to be persuaded of the value of the logical faculty, but we may remark that, although it cannot but be trained by the study of mathematical problems, yet that in the solution of the problems of life it is very possible to find that personal bias is so strong as to prevent its exercise.

From these premises we might reasonably argue that more attention should be paid to the application, in different directions, of the observing powers and of the reason. Further, I believe we should do well to admit more generally than we do that in the higher walks of science the reason must often be preceded and supplemented by what we must regard as even a loftier faculty, inasmuch as when present in a high degree it amounts to genius—I mean the imagination. I should like to insist a little on this, because of its great importance. Whether from the belief entertained by many that the imagination is not required on the scientific side of education, or from over-haste in education, which is the very natural result of an age of nervous over-pressure, I cannot tell, but the result has been that little provision has been made for its exercise in purely scientific schools—this in spite of the fact that it seems to be a natural concomitant to training by experiment on account of its close relation to visual memory.

The imagination could be made of the greatest service in the proper study of science, and would, if rightly used, prevent much of the cramming, against which we are all setting our faces. It should then be possible to train it, even by the study of science; but a more rapid stimulus would probably be found in the reading of good literature, history, poetry, and the study of art in any form—subjects often received by science students with a feeling akin to contempt, as being unworthy the serious attention of a really practical man.

Yet the search for ideal truth, like the search for ideal beauty, requires the imagination as its instrument, and to leave out one of the most important means to the end we wish to reach is clearly not science; therefore, I say, let us cultivate the imagination, and if the introduction of other subjects into a scientific course is really the quickest way to that end, let us introduce them into the training, but let us devise means to prevent their becoming merely a fresh tax upon the students' time. As a matter of practical politics this may be ensured, I believe, by studying them, not with the view of acquiring knowledge, but strictly with the view of acquiring a power.

We have said that the scientific man should be a man of practical capacity, the man who can *do*, and, if possible, the man who can *make*—powers which do not always go together. Generally speaking, our schools of science succeed in training the latter, but very little importance seems to have been attached to the necessity of giving any training in the former. Nor does it appear to be safe to leave it to instinct, as the not uncommon proceeding of students, viz. to dawdle through a term and cram at the end, is the very last manner in which it would be desirable to "put through work" in after life. The power of dealing with men in every relation of life and of learning, to some extent, the responsibilities of citizenship should be provided for in a reasonable degree by encouraging social intercourse, by the promotion of clubs for mutual improvement and recreation, especially those for the discussion of the problems of the day. In such ways the student may learn to handle affairs both of business and of citizenship.

Of course we cannot make bricks without straw, and we must recognise that if all this is to be done, or even aimed at, it will take time to do it, which brings me to the general subject of over-pressure, a burning question in these days, when by perpetual competition, from the very earliest years, we risk spoiling our best intellects in the endeavour to quicken the sluggish current of our duller minds. The standard of quantity in learning, like the price of food, seems to be perpetually rising, and as the human mind shows no very lively signs of expanding in direct proportion, but, on the contrary, shows some tendency to collapse, it would seem to be well to think more of quality in work and less of quantity. We must remember that forced growth in plant or man is in the end destructive. The day of the grammarian, celebrated by the poet, is perhaps gone, and it is more than doubtful if we want to read his whole book; but we should do well to take at least a page out of it, and allow our ideals to be, not shaped, but modified by the splendid sentiment, "Leave *now* for dogs and apes, man has forever."

If, then, we could plan our curriculum with more provision for this training of the powers, as apart from actual professional work, and with at least a tacit recognition of the fact that rest and recreation must follow mental exertion, and *precede* more exertion if that "more" is to be effective, I think it would be possible to require a much higher quality of work and make up for omissions in detail of direct training, which, after all, if one knows how, can be learned in the first stages of practice which follow college life. This little phrase, "if one knows how," should really indicate the difference between the man who enters shops direct and the man who enters them after college work. Our results in practical work should, if we are on the right track, prove, what is not questioned any longer in many places, that the college graduate is the man who is wanted in business life.

As to those higher elements of character, without which no education is of much avail, in these especially the training must be indirect, but never neglected. In every college there are endless opportunities for self-knowledge, self-control, and, if a man so choose, for self-sacrifice. In a *scientific* college there are special influences making for the development of character. The constant effort to eliminate error tends towards the development of truth and accuracy. The cultivation of the will in overcoming obstacles should produce the sturdier manly virtues; the patient waiting on nature's working encourages the gaining of a wise self-restraint, which we may hope to see employed in the directing of life; and the emphasis laid on the pursuit of truth for its own sake should help to overcome the spirit of commercialism—that caring for scientific success mainly for what it will bring in financial success—which is an ever-present danger of the application of science to life.

We see then, in general, that we should like to make it our aim in the Imperial College to develop scientific education both on the imaginative and on the practical side by, on the one hand, bringing our men into somewhat closer touch with the noblest thoughts of the past and with the world-wide strivings after truth which characterise our present age; on the other hand, by inviting the advice and cooperation of men of business and of professional men in actual practice, so as to keep our courses in accord with their methods, and, if possible, to earn the reputation of being the place where an employer must easily find the man he requires.

Finally, we consider that if we can succeed in training men to be at once good scientific men and good citizens, we shall have done the best that is possible to serve our country by giving to it a class of workers who can be trusted to put the true service of man above their personal success, who are willing patiently to search for truth in hidden and dangerous places, who will be able to follow true laws of economy, and to prevent some of that waste which we now see going on in painful contrast to the destitution which runs parallel with it. Such men often show a capacity for leadership through individual force of character, and are no less ready to follow with unselfish devotion the path of common duty.

With grateful pride we may say that, to a high degree, these things have been already achieved by the associates of the several institutions now uniting in the Imperial College. We recall the eagerness with which some of our students went to serve their country in South Africa. A tablet has recently been set up in the Royal College of Science to keep their memory before us. We believe that of very many, had they found a chronicler, similar things might have been written as were actually penned by a western poet about one of the Associates of the School of Mines:—

> The men he worked or
> Say judging as best they can,
> That in lands which try manhood hardest
> He was tested and proved a man.

In conclusion, I am permitted to make some very pleasant announcements. The Bessemer committee has provided, as most of you are aware, for the equipment of the mining and metallurgical laboratories in the new building, of which the first plans have already been prepared by Sir Aston Webb, and the erection of which is to be commenced in the near future.

Again, a gentleman [Mr. C. Hawksley], who I am glad to see is with us to-day, has very generously consented to equip and endow a hydraulic laboratory, which, we hope and believe, will render it possible to investigate many problems of flow which have not heretofore been attempted.

I am sure, too, that it will be no small satisfaction to all those present that, with His Majesty the King's hearty approval, steps are being taken to equip and endow certain other important laboratories.

Many and valuable donations, too numerous to mention in detail, have also been received from Canada and the United States, for which we are most grateful.

Lastly, the roll of honour of those who have occupied the chairs in the different sections of the Imperial College is a very long one, and includes many names which have made England famous in the world of science. I cannot but think that many would like to have a permanent memorial to the names of such men in the form of chairs, laboratories, scholarships, or library endowments. In this matter of giving I should especially wish to enlist the sympathy of the Associates who leave these halls year after year. None have contributed more to the success and advancement of the universities of America than their own graduates. Every college of importance has an alumni association. The class sent out each year appoints its own secretary, who is expected to keep in touch with all its members, each of whom contributes a small sum annually to a special fund intended to help his alma mater. Most excellent has been the result of the scheme. Thus, at one of the great universities, a sum of 10,000*l.* is annually given for general purposes, while a large reserve is always available for any special need. A further advantage is found in the fact that the alumni are always kept in close touch with their college, are imbued with a real *esprit de corps*, and consider it not only a duty but a pleasure to help the institution which has prepared them for their life's work.

There is a grand opportunity for benefactions in the Imperial College if progress is to be maintained and if, as we hope and expect, we are to become the central, the Imperial Scientific School, imperial in conception, imperial in our sphere of work.

## GEOGRAPHY AT THE BRITISH ASSOCIATION.

THE geographical section of the British Association this year was particularly fortunate in the meeting place allotted to it, for better accommodation could not be desired than that afforded by the theatre in the Royal Dublin Society's building in Kildare Street.

Opening the sectional meeting on Thursday, September 3, the president, Major E. H. Hills, took as his subject the survey of the British Empire. His address amounted to a plea for the more thorough organisation of the Imperial survey, and he dealt with the work, not only retrospectively, but prospectively, analysing present methods, discussing their shortcomings where such exist, and suggesting plans for the future. One of his most notable recommendations was that the re-measurement of the two principal arcs, meridional and longitudinal, should be undertaken by the British Ordnance Survey, and this recommendation was afterwards embodied in a resolution forwarded by the sectional committee to the council of the association, suggesting that the Board of Agriculture and Fisheries (which controls the Ordnance Survey department) should be memorialised to this effect, and the committee of Section A (Mathematics) gave support in a similar resolution. Major Hills alluded to the adverse effect of the lack of good maps on British operations during the South African war, and showed that the possibility of a similar occurrence in future was not yet removed. Major Leonard Darwin and Sir David Gill, who respectively proposed and seconded a vote of thanks for the address, urged the same point, which was commented upon by a section of the Press as an adverse reflection on the work of the British Government offices in this direction. Major Darwin, therefore, on the following day, with Major Hills's support, made it clear that no such reflection was intended. Where the work of the Colonial Office was unfettered, they said, it was now admirable.

Prof. W. M. Davis, of Harvard University, who subsequently during the meeting gave a brilliant evening lecture on the Colorado cañon, now gave a short lecture on the physiographic subdivisions of the Appalachian mountain system in the east of the United States. He divided the system into a crystalline longitudinal belt to the south-east and a stratified longitudinal belt to the north-west, distinguishing from both the Appalachian plateau to the north-west again. After elaborating the physical aspect of the system, Prof. Davis went on to demonstrate its effect on early settlement, and showed the peculiar interest of the Appalachians as offering the first barrier to the penetration of the country from the east, but he also showed how certain clearly defined routes were afforded through the barrier. The afternoon lecture was popular in character, and attracted a very large audience for a sectional meeting; it was given by the Rev. W. Spotswood Green, of Dublin, who, under the title of "Ireland: her Coasts and Rivers," addressed himself mainly to those visitors who might be enabled, through the organised excursions of the association or by subsequent travel, to see more of Ireland than its capital. Following geographical methods, he appended to a brief physiographic description of the island remarks on a variety of historical (mainly antiquarian) topics, and illustrated all with admirable lantern-slides.

On Friday morning (September 4) a full audience was attracted to two papers on different aspects of geographical education. Prof. R. A. Gregory, treating the subject in a general manner in his paper on "School Geography as a Mental Discipline," brought out the fact, which, though being slowly realised, must still be constantly insisted upon, that the proper teaching of geography does not consist in the impression of lists of names and disjointed facts on the student's memory. In his paper, and the remarks of speakers who followed him, it was shown that geographical causes and their political, economical, or other effects must be taught in an orderly perspective. Moreover it is desirable, not merely to present facts and their reasons to the student, but also to train him to deduce reasons from facts for himself. Dr. A. J. Herbertson, in opening a discussion on the paper, supported the reader in laying stress on the utility of work in the field and also of instruction in the reading of maps, and all the inferences to be drawn from cartographical representation. The difficulty of finding teachers qualified to teach geography properly was insisted upon by more than one speaker, and finally Major W. L. Forbes enlarged upon the necessity of establishing geographical lectureships at all universities, where training for teachers might be obtained.

Prof. J. L. Myres' paper, which followed, was an admirable disquisition on the value of geographical study applied in a special connection. Speaking on the geographical study of Mediterranean man, considered as an element in a "classical education," he said that the "classical education" as generally conceived and given took no account of geographical environment. Yet only the study of that environment could provide a proper background for the picture which it was desired to impress upon the minds of students. His argument led finally to the conclusion arrived at in the preceding discussion—that classical teachers are not yet generally equipped to give geographical instruction. The Rev. T. Corcoran pointed out a fact both novel and of interest to many of his hearers—that German classical cartographers appear by their work to have been at fault in confining their studies to the Latin, to the exclusion of the Greek world. At the conclusion of this educational discussion Dr. W. S. Bruce showed lantern-slides illustrating the expedition of the *Scotia* in the Antarctic, and alluded to the publication, now in progress, of the scientific results of that expedition.

Mr. W. L. Grant, assistant to the reader in colonial history at Oxford University, lectured in the afternoon on the northward expansion of Canada. His lecture was framed with especial reference to the visit of the association next year to the Dominion, and he pointed out the particular importance of Winnipeg, the place of meeting, as the point of junction in the lines of communications between east and west. As these lines are at present laid down, the developed portions of Canada resemble a wasp in shape, and Winnipeg is situated at its narrow waist. A noteworthy point made by the lecturer was that in the development of the North-West railway construction must precede settlement, not follow it—a sequence hardly to be conceived by those without experience of pioneer work.

On Monday morning (September 7) Mr. E. A. Reeves exhibited and explained three instruments recently designed by him for the use of surveyors and travellers:—(1) a distance-finder alidade for plane-tabling; (2) an astronomical compass and time indicator; (3) a new form of reflecting artificial horizon. Mr. H. G. Fordham read a paper entitled "Notes on the Cartography of the Counties of England and Wales." This paper has been privately printed, and is of great value for reference in a subject which has not hitherto received deserved attention. Mr. Fordham stated that, taking Hertfordshire as an illustration, no less than about 400 maps of that county have been published, about half of which, however, are reprints, more or less altered from the original plates. In this connection it was interesting to recognise, in some of the less reputable maps which are issued to-day for road-users, plates about a century old, though of course brought up to date. Mr. Fordham exhibited a large number of maps, which were inspected with great interest at the conclusion of his paper. In the afternoon Captain H. G. Lyons, of the Egyptian Survey, who was the recipient of an honorary degree of Trinity College during the meeting, read a paper on the longitudinal section of the river Nile. He showed that an almost complete line of levelling existed along the river from Victoria Nyanza to the Mediterranean Sea, a distance of 3500 miles. After the main river debouches from the elevated equatorial plateau upon the level plain of the Sudan, it and its tributaries have the very slight slope of 3 inches, or little more, to the mile. But the flattest part of the whole course is between the Sobat and Khartum, where the slope is from one-half to one-third of an inch per mile. The well-known cataracts are rapids where the river erodes the crystalline rocks which alternate with sandstone. The latter is, of course, laid over the crystalline rocks, but these are not of level surface, and the river has cut down the land far enough to expose their greater elevations. Below Assuan, where the lowest of these cataracts occurs and the great irrigation dam is situated, the river has formed alluvial plains, and is building them up at the rate of about 4 inches per century. The work of the river is erosive in the equatorial plateau region; in the plain of the Sudan it deposits its load of solid matter, and thus raises the land; in the cataract reaches it erodes again, and below these, down to the delta, it again builds up.

As a whole, the papers given on Tuesday, September 8, proved the most popular. They were of the sort to do so, as all were mainly descriptive and all were illustrated with lantern-slides. The Rev. George Furlong's paper, entitled "Unique Experiences at the Birth of a Volcano," attracted the largest audience of any attending the section; the number present did not fall far short of 400. They were kept fully interested, for Mr. Furlong showed that his claim to unique experiences was justified. He was a missionary in Savaii, Samoa, when the volcano of O Le Mauga Mu, after a period of earth unrest, first broke into life, and he witnessed, and carefully observed and photographed, often under great difficulties, the phenomena accompanying the outbreak and the opening and building up of the crater. Some of his photographs were highly impressive, especially those of the eruption of steam where the hot lava flow reached the sea; and though he disclaimed scientific ability, some of his observations were of much scientific interest. For example, he had no doubt that the volcano was more active during the period of full than of waning moon; he noted a marked variation in the character of the fumes from the volcano at different times, and he was able to correlate the occurrence of a succession of tidal waves with periods of more than usual activity on the part of the volcano.

Mr. L. C. Bernacchi, well known in connection with the voyage of the *Discovery* in the Antarctic, now brought forward an account of his journey in the little explored Rio Inambari region of Peru, where a new field for the rubber trade is opening up. Dr. W. S. Bruce gave an account of his surveying and accompanying scientific work on the island of Prince Charles Foreland in the Spitsbergen group, an island known for three centuries, but never hitherto surveyed. A committee of the section, with a grant from the association, had assisted Dr. Bruce in his work, and his lecture was an elaboration of the report of the committee. He has produced an almost complete detailed map of the island, which has an area of 271 square miles, and has studied its geology, zoology, botany, and meteorology. It may be added here, with regard to the other committees of the section appointed for scientific research, that Mr. R. T. Günther has practically completed his investigation of the oscillation of the land-level in the Mediterranean region, and that Mr. J. Stanley Gardiner's investigations in the Indian Ocean and Dr. A. Strahan's study of rainfall and run-off in certain English rivers are in active progress.

On Tuesday afternoon the meeting of the section was brought to a close with two papers on a subject of local interest, which pointed to a field for new investigation lying at our doors. Mr. Harold Brodrick gave the results of his explorations and measurements in some of the limestone caves of the county Fermanagh—Marble Arch Cave and others in the vicinity; while Dr. C. A. Hill spoke of the Mitchelstown caves in the county Tipperary, one of which, though frequently visited by tourists, is far from having been explored in its entirety, while the other, though discovered at a much earlier date, is never visited now. These caves, unlike those described by Mr. Brodrick, which are underground water-courses, are the product of a hydrographic *régime* no longer extant; they are no longer subject to water action, being practically dry, and their high antiquity, thus proved, gives them a peculiar interest.

## *EDUCATION AT THE BRITISH ASSOCIATION.*

A VERY full programme was arranged for each of the four morning meetings, and the attendance of members, although never very large, was remarkably sustained throughout the sessions. In the afternoons visits were paid to schools of varied types, and no pains were spared by the staffs of the institutions in their endeavour to make these visits as instructive as possible. It was evident that the majority of those present at the discussions were engaged in teaching or in educational administration. The "popular" side of Section L has given way to the professional side, which is as it should be.

The thoughtful address given by Prof. Miall sounded the right note of scientific investigation and careful criticism (*vide* NATURE, October 8). Prof. Armstrong followed the president with a paper entitled "The Outlook: a Grand Experiment in Education." The author took an optimistic view, chiefly based on his observation that a more practical treatment of the scholar prevails than was the case a few years ago. Schoolmasters and mistresses were beginning to recognise that English really was a language, but the brightest spots were the schools at Osborne and Dartmouth. With the advantages of naval discipline and *esprit de corps* the sailor had cut the Gordian knot and broken down the old tradition that the school was a place for literary study. Experimental schools should be introduced into the country, but the hand of the builder should be stayed until it was known what was required. He asked for a Royal Commission of Inquiry, consisting of a few competent persons, who should study existing methods of education and make recommendations.

Mr. R. Blair (executive officer of the London County Council) followed with a paper dealing with the progress made in the organisation of education in the area under the authority of the council. Some idea of the magnitude of the task performed may be gleaned from the annual expenditure, which is four and a half millions sterling on elementary and one million on higher education. In the elementary schools the subjects of instruction, in addition to those usually found in public elementary schools, include elementary science, nature-study, domestic economy, manual training, physical exercises, swimming, and in certain cases modern languages. By means of conferences and consultative committees the twenty thousand teachers employed have opportunities of expressing their views on the management of the schools. In addition to training their own teachers to the standard of professional qualification required by regulation, the council provides for further training of practising teachers in connection with London University. The extensive and highly varied work of technical education, from the ordinary evening school to the polytechnic, is being coordinated. With regard to secondary education, the policy of the council is to provide, or assist in providing, secondary education at a moderate fee for those who are able to avail themselves of it, and to offer the advantages of secondary education free of charge to the most promising children from the elementary schools. Omitting private schools, half the pupils are in secondary schools aided by, and nearly one-tenth in those belonging to, the council. Physical education, organised games, and medical inspection are now receiving a large amount of attention, and open-air schools have been included in the experiments made to deal with physical defects. Necessitous children receive meals through voluntary funds. As an instance of the scale on which the authority works, we note the item of 900,000 plants and other nature-study specimens supplied monthly by a small botanical department. We can only mention that Mr. Blair expounded clearly the principles which guided the authority (1) in its provision of accommodation for pupils in elementary schools; (2) in its provision and award of scholarships; (3) in the training and promotion of teachers.

Mrs. E. M. Burgwin then read a paper on special schools for the physically defective and the mentally deficient. The permissive Act known as the Elementary Education (Defective and Epileptic Children) Act, 1899, enables an education authority to take charge of feeble-minded children (not imbeciles) until the age of sixteen. The late London School Board opened its first special school in 1892, and there are now in London eighty-four schools, with a roll of 6006, for the mentally deficient, and twenty-eight schools, with a roll of 2255, for the physically defective. In the case of the mentally deficient, the schools aim at developing intelligence through the motor senses. The aim in teaching the physically defective is to train them to become good workers in spite of their infirmity; for this, expert trade teaching for four years before leaving school is necessary. Only by decreasing tuberculosis can we reduce the number of cripples.

The second morning was devoted to practical instruction in elementary schools and to education in relation to rural life. Sir Philip Magnus prefaced the reports of the committee on elementary experimental science studies in elementary schools with a review of work accomplished since the appointment of the committee at Southport in 1903. He took the opportunity to congratulate the Irish people on the passage of the Irish Universities Act, and on the prospect thereby afforded of securing for all classes of citizens further opportunities of higher education. He sincerely hoped that those who were training to become teachers in elementary schools might reap the advantage of the wider learning and broader views of life which residence at a university offered. Mr. W. M. Heller read the report of the subcommittee, which insisted upon including in the curriculum experimental work to be performed by the pupils. More attention should be paid to aims and methods in teaching elementary science, and inspectors should understand both subject-matter and methods. Particular emphasis was laid on the importance of training girls in the methods of experimental inquiry. With the report are four appendices containing alternative syllabuses and a list of apparatus.

A thoroughly well-sustained discussion on rural education was opened by Prof. Miall, who urged teachers to lead their pupils to see, handle, and think for themselves. It was regrettable that so many artificial aids—pictures, ready-made preparations, &c.—were employed. Referring to school gardens, Mr. David Houston urged that the education of the child must come before the desire to have a prolific garden. Miss Lilian Clarke described her methods used at Dulwich, and Mr. George Fletcher detailed a course of classes in rural economy which has been given to certain teachers by the Irish National Board of Education. Mr. Fletcher said that it was less a question of the introduction of a new subject into the curriculum than the infusion of a new spirit into the system. If every school in town and country possessed and utilised freedom to make its surroundings a means of education, the problem would be in a fair way to solution. He urged the value of carefully arranged summer courses of instruction for teachers, as the new spirit could only come through the teacher. The audience heartily approved Mr. Fletcher's statement. Mr. C. H. Bothamley gave an account of the fairly successful efforts made to promote rural education in certain English counties, referring particularly to Somerset. The Very Rev. Dr. Delaney expressed the opinion that, alike in the training of children and of teachers, the fetish of examinations was the curse of education. Mr. J. Hegarty, a member of the Co. Dublin Teachers' Committee, pointed out that school gardens would not give a desire for rural living while agricultural wages were so low. Miss Constance Cochrane believed that small holdings would go a long way towards promoting the success of agricultural education—where these had been established she had seen the greatest keenness on the part of both parents and children to learn all they could from the school gardens; where there was no prospect of a holding, the boys' wish was to get away from the country. Miss Cochrane added detailed advice, based on successful experience as a school manager in remote rural districts. The Rev. Dr. Kingsmill Moore, principal of the Church of Ireland Training College, deprecated specialisation in the early education of children. Their object must be, not to fill the mind, but to make it capable of filling itself.

Education in Ireland was the leading subject at the Monday meeting. According to the printed programme, the discussion on this subject was to have been preceded by one on tests of educational efficiency. However, on the request of the committee of the section, the opener, Mr. T. P. Gill (Secretary of the Department of Agriculture and Technical Instruction for Ireland), merged the question of efficiency tests in the consideration of the situation in Ireland, and his paper led to an animated debate. In his original abstract he had considered educational tests under three aspects:—(1) Physical: the effect upon bodily development; health; intellectual efficiency and moral strength as depending on health; manual training; discipline. (2) Mental: the development of observing, thinking, and correlating power; the avoidance of cram. (3) Moral: the test here should aim at ascertaining whether the teachers have the right outlook and influence; whether the pupil is being led to know and love the right things; to understand his private and public duties; to select true aims in life. Mr. Gill welcomed the opportunity of discarding more abstract themes, and turned to the Irish situation at the present moment. The country had to organise a new university system, and he looked forward to such a reform as would produce a truly national education, not, as in the past, imposed from without, but developed by Irish thought concentrated effectively upon this aim. He considered that the educational mill had worked recently in a manner calculated to manufacture a half-baked and inefficient nation, the special target of his criticism being the intermediate schools. He looked forward to a day of intellectual freedom for these schools, when inspection would be substituted for examination. The main impulse for these reforms must come from the universities, and they now had to consider and settle upon their purpose and ideal. They had to create, not only a congeries of professional schools, not only a machinery for research, but an intellectual and moral centre for the nation.

Prof. Benjamin Moore followed with a paper on correlation of primary, secondary, and university education in Ireland. There has been no coordination between the chief bodies—the Board of National Education, which controls the national schools; the Intermediate Board, which exerts bureaucratic sway over intermediate or secondary schools; the universities, which have hitherto taken no share in moulding either the primary or the secondary education of the country. The changes necessary may be summarised as follows:—(1) Primary or national education: the training of the teachers should be under the faculty of education in the university. (2) Secondary or intermediate education: each university within its own sphere of influence should recognise secondary schools, and the university, acting in sympathy with the teachers of the schools, should test the work of the pupils; the system of work should be drawn up by each school with the approval of the university.

The Rev. Dr. Evans defended the action of the Board of National Education, and Prof. Culverwell supported the views expressed by Prof. Moore. The Rev. Canon Mahaffy admitted the existence of serious drawbacks in Irish education. Poverty, the drain of emigration (leaving the feebler behind), and the lack of a sense of duty in regard to school attendance, were responsible for defects, and it was not fair to attribute these to the schools. The system was not such a failure as Mr. Gill had made out, and there was no want of high moral teaching in their schools. The Rev. T. Corcoran would rather modify the examination system than put the teacher under the inspector, with consequent loss of freedom. Subsequent speakers referred to the pay of the teachers, and the Rev. Dr. Delaney warmly sympathised with the strong condemnation passed on the miserably insufficient payment of the teacher in the elementary schools. He also referred to the university question, and approved the Liverpool University charter, which includes representative men of Liverpool and neighbouring counties.

Miss C. P. Tremain opened the discussion on the important question of training in teaching. She pointed to three stages in such training:—(1) General education in school and university college. (2) Professional training, including instruction in the theory and practice of education and hygiene. The longer course for intending elementary-school teachers, where the students pursue degree and training courses together, is less successful than the short, intensive post-graduate course for intending secondary-school teachers. The aim is not to produce finished and perfect teachers, but rather aspiring and intelligent ones who will be able to adapt themselves to and learn from subsequent experience. (3) The experience stage of training. Valuable assistance would be rendered if secondary schools directed more attention to the mother-tongue, drawing, clear enunciation, and physical culture. Mr. Charles MacGregor, as the second speaker on this subject, sketched a system of training which would occupy three years for non-university students and four years for those following a university course. In explaining the principles of such a scheme he emphasised the need for child-study, for study of recent history of education, and for accustoming students to the idea of experiment in education.

The programme for the last day was a crowded one, and the discussions on the topics were much curtailed. First came the report of the subcommittee upon the sequence of science studies in secondary schools, which was read by Mr. G. F. Daniell. The first half of the report summarised the replies received to a number of questions addressed to science masters in different types of school. Speaking generally, there is remarkable agreement as to the subjects taught and the order in which they appear in the curriculum. There is also close agreement as to the aim of science teaching, but a great diversity in method. The committee believes this diversity to be healthy, as it desires that the teacher should have a large liberty in the choice of his methods. It deprecates the discouragement of improved methods which is found to result from the existing system of preparing for examinations. Two useful tables in the report indicate the usual science subjects in schools where the leaving ages are sixteen and eighteen respectively, and the average

age at which they are studied. Among the recommendations are the following:—(1) the teaching of elementary physical measurements should form part of the mathematical course; (2) preparatory schools should teach natural history (including some physical geography) and the rudiments of physics; (3) qualitative work deserves respect, and good scientific literature and lectures should not be underrated; (4) the claims of geography and biology should receive more recognition; (5) all science work of boys should be brought into closer touch with everyday experience; (6) more laboratory assistants should be provided. Mr. Eggar commented on the report, and asked for attention to the historical order of discovery in framing courses of instruction.

Next on the programme came an open discussion on note-taking and reports of work, which was initiated by the president. Prof. Miall, and subsequently Mr. Fletcher, advised that pupils be trained to arrange their work under heads and subheads, and that these should be the most important feature of their notes. The use of intelligible contractions was advisable. Prof. R. A. Gregory directed attention to the waste of labour by writing as lecture-notes matter which was easily available in books. The Rev. T. Corcoran urged that the mapping of histories should be performed by the students themselves. He also advocated the introduction of "scientific" note-taking into classical subjects; in other words, the teachers of classics should take a leaf out of the book of their colleagues on the scientific side. Dr. Kimmins had been impressed with the good quality of the note-taking by American boys and girls; they showed the capacity to seize upon the important point in an argument. He objected to the waste of time involved in making fair copies of notes, while admitting that parents gloat over elaborate note-books. Mr. Mayhowe Heller expressed doubts as to the wisdom of demanding notes from quite young students.

The discussion on clear speaking and reading aloud was opened by Mrs. Mackinnon, who fell under the suspicion of giving us an object-lesson in this art. Besides attending to final consonants and making the children read at a distance from the audience, she made the child give an epitome of the passage before attempting to read aloud. This secures that what is to be read has been understood, which is absolutely necessary for good reading. Miss Cooper wished more attention to be given to phrasing, including stress and pause. Prof. Miall pleaded for a revival of reading aloud in the family. The Rev. Dr. Delaney having stated that boys come to the university unable to speak properly, despite the years spent in secondary schools, Mr. G. F. Daniell suggested that boys ought to be taught to speak well after, as well as before, the break of voice. Dr. Ernest Gray raised the question of the influence of phonographic writing on speaking. He also spoke of the way in which speakers turn their heads without turning their bodies, and pointed out that no successful orator falls into this error.

Dr. G. Archdall Reid gave a paper on acquirement in education. He stated that everything we learn is acquired. The new-born baby is not intelligent; he has only great capacity to learn to become intelligent. When we send a child to school we design that he shall not merely learn knowledge more abstruse than that which he can pick up, like a savage, from the ordinary experiences of life, but also acquire right habits of thought or mental dexterities. The best educational subjects at the same time supply useful knowledge and exercise the thinking faculty. Knowledge to be useful must be remembered; to be remembered it must link up with our subsequent experiences. Prof. Culverwell disagreed with many of Dr. Reid's views, and put forward theories relating to mental change and the transference of energy within the brain. Profs. H. Browne and R. M. Henry upheld the teaching of classics, and Principal Griffiths objected to the fight between the protagonists of science and classics as a mischievous and unnecessary quarrel.

Prof. J. A. Green read an important paper on experimental studies in education. The author gave a sketch of work which is being prosecuted abroad which will greatly help to lay a wise foundation for future teaching practice. The teacher, as such, is not primarily a researcher, but he wants the results of research in a usable form, and university departments of education should be organised so as to provide them. Laboratories have already been instituted in Antwerp, St. Petersburg, Leipzig, Milan, and Budapest for experimental inquiry into the problems which confront the teacher. Miss Foxley gave an account of the work which is being done in Manchester under Prof. Findlay's direction. The audience was impressed with the importance of the subject, and heard with pleasure that a research committee of Section L has been appointed, with Prof. Findlay as chairman and Prof. Green as secretary, to inquire into the methods and results of research into the mental and physical factors involved in education.

By kind permission of the authorities, visits were paid to Maynooth, Loreto Abbey Convent School at Rathfarnham, Wesley College, Christian Brothers' Schools, Alexandra College, Mountjoy School, and Artane Industrial School.

The section was indebted to the Rev. T. Corcoran for a useful exhibit of maps to aid in the teaching of Greek and Irish histories.

The interim report on the conditions of health in schools, prepared for Section L, was presented in the Physiology Section. It was, unfortunately, impossible to arrange a joint meeting of the two sections. Reference was made to the relation between the educational and other sections of the association by Sir Philip Magnus at the opening meeting. He pointed out that Section L was able to help the other sections by discussing the methods of teaching the various branches of science with which they were concerned, and he hoped that the older sections would refer to the education section the consideration of problems relating to methods of instruction.

Twenty-two educational associations were officially represented at the meeting, and it is desirable that means should be devised to render the interest thus displayed of more effect in promoting the work of the section and in spreading the influence of that work.

G. F. DANIELL.

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*Edward Arnold.*—In Search of a Polar Continent, A. H. Harrison, illustrated; On Safari: Big Game Hunting in British East Africa, A. Chapman, illustrated; Five Months in the Himalayas: a Record of Mountain Travel in Garhwal and Kashmir, A. L. Mumm, illustrated. *John Bale, Sons, and Danielsson, Ltd.*—My Life Among the Wild Birds of Spain, Colonel W. Verner, illustrated. *A. and C. Black.*—The Round World, J. Fairgrieve, illustrated; Buried Herculaneum, E. R. Barker, illustrated; Egypt in Asia: a Plain Account of Pre-Biblical Syria and Palestine, Rev. J. Baikie, illustrated. *W. Blackwood and Sons.*—A Wandering Student in the Far East, the Earl of Ronaldshay, illustrated. *The Cambridge University Press.*—Yün-nan, the Link between India and the Yangtze, Major H. R. Davies. *A. Constable and Co., Ltd.*—Ruenzori, an Account of the Expedition of H.R.H. Prince Luigi Amedeo of Savoy, Duke of the Abbruzzi, to the Snow Ranges, situated between the Equatorial Lakes of Central Africa, Filippo de Filippi, illustrated. *Duckworth and Co.*—A Handbook of Geography, Descriptive and Mathematical, Dr. E. Reich, 2 vols., illustrated. *W. Heinemann.*—Conquering the Arctic Ice, Ejnar Mikkelsen, illustrated; Persia: the Awakening East, W. P. Cresson, illustrated; The Fijians: a Study of the Decay of Custom, B. Thomson; Syria, Gertrude Lowthian Bell, illustrated (cheaper edition of The Desert and the Sown); Dan to Beersheba: Work and Travel in Four Continents, A. R. Colquhoun. *John Lane.*—Kashmir: the Land of Streams and Solitudes, P. Pirie, illustrated. *Macmillan and Co., Ltd.*—Notes of a Botanist on the Amazon and Andes, being Records of Travel on the Amazon and its Tributaries, the Trombetas, Rio Negro, Uaupés, Casiquari, Pacimoni, Huallaga, and Pastasa; as also to the Cataracts of the Orinoco, along the Eastern Side of the Andes of Peru and Ecuador, and the Shores of the Pacific, during the Years 1849–64, Dr. R. Spruce, edited and completed, by means of journals, letters, unpublished MSS., and other materials, by Dr. A. Russel Wallace, F.R.S., 2 vols., illustrated; Alaska—the Great Country, E. Higginson, illustrated; Highways and Byways of the Pacific Coast, C. Johnson, illustrated. *John Milne.*—The Heart of the Wild: Wild Life Studies from Near and Far, S. L. Bensusan, illustrated. *John Murray.*—The Life of Philibert Commerson: an Old-world Story of French Travel and Science in the Days of Linnæus, the late Captain S. P. Oliver, edited by G. F. Scott Elliot, illustrated; The Shores of the Adriatic, the Austrian Side: an Architectural and Archæological Pilgrimage, F. H. Jackson, illustrated. *G. Philip and Son, Ltd.*—Martin Behaim, his Life and his Globe, E. G. Ravenstein, illustrated, and a facsimile of Behaim's famous globe; further volumes of Mackinder's Geographical Studies: A Course of Elementary Studies in Geography, H. J. Mackinder, Book ii., Lands Beyond the Channel; Book iii., Distant Lands; and Book iv., The British Empire; Philips' Geographical Illustrations, Set i., P. H. L'Estrange; A Guide to Geographical Books and Appliances, a new edition of Dr. H. R. Mill's Hints to Teachers and Students on the Choice of Geographical Books for Reference and Reading, with Classified List, prepared by J. F. Unstead and N. E. MacMunn, edited by Dr. A. J. Herbertson. *Sir I. Pitman and Sons, Ltd.*—Notes of Lessons on Geography, L. Marsh, 2 vols. *G. P. Putnam's Sons.*—The Great Plains, R. Parrish; A Canyon Voyage: the Second Powell Expedition down the Green-Colorado River from Wyoming, and the Explorations on Lane in the Years 1871 and 1872, F. S. Dellenbaugh, illustrated; The Niagara River, A. B. Hulbert; Historic Indiana, J. H. Levering. *T. Fisher Unwin.*—Mountaineering in the Land of the Midnight Sun, Mrs. A. Le Blond, illustrated.

### Geology.

*Appleton and Co.*—Minerals, L. J. Spencer, illustrated. *Edward Arnold.*—The Geology of Ore Deposits, H. H. Thomas and D. A. MacAlister, illustrated. *W. and R. Chambers, Ltd.*—The Wonder Book of Volcanoes and Earthquakes, Prof. E. J. Houston, illustrated. *A. Constable and Co., Ltd.*—Essays on Geological Subjects, Prof. J. W. Gregory, F.R.S. *Milner and Co., Ltd.*—Geology, G. Hickling. *Swan Sonnenschein and Co., Ltd.*—A Textbook of Petrology, Dr. F. H. Hatch, a new and enlarged edition, illustrated.

### Mathematical and Physical Science.

*A. and C. Black.*—Analytical Geometry of the Conic Sections, Rev. Dr. E. H. Askwith, illustrated. *The Cambridge University Press.*—Dynamo-electric Machinery, C. E. Ashford and E. W. E. Kempson; A Treatise on Spherical Astronomy, Sir R. S. Ball, F.R.S.; A Course of Pure Mathematics, G. H. Hardy; The Thirteen Books of Euclid's Elements, a new translation from the Greek, with introduction and notes, Dr. T. L. Heath, in 3 vols.; Scientific Papers, Sir G. H. Darwin, K.C.B., F.R.S., vol. ii., Tidal Friction and Cosmogony; Cambridge Observations, vol. xxiv., part i., Measures of Double Stars made with the Northumberland Equatorial of the Cambridge Observatory under the direction of Prof. Challis in the years 1839–44; An Introduction to the Study of Integral Equations, Prof. M. Bôcher. *W. and R. Chambers, Ltd.* The Wonder Book of Atmosphere, Prof. E. J. Houston, illustrated; Electricity for Young People, T. Jenks, illustrated; Photography for Young People, T. Jenks, illustrated. *A. Constable and Co., Ltd.*—Smoley's Parallel Tables of Logarithms and Squares: Angles and Logarithmic Functions. Corresponding to given levels, together with a complete set of Five-figure Logarithmic-trigonometric Tables for Engineers, Architects, and Students, C. Smoley; Smoley's Parallel Tables: Five-place Logarithmic-trigonometric Tables, C. Smoley. *Gauthier-Villars* (Paris).—Exercises et Leçons d'Analyse, R. D'Adhémar; Leçons sur les Théories générales de l'Analyse, Prof. R. Baire, 2 vols., illustrated; La Mesure rapide des Bases géodésiques, R. Benoit and C. E. Guillaume, new edition, illustrated; Œuvres de Pierre Curie, illustrated; Mesures électriques, E. Gerard, new edition, illustrated; Leçons d'Electrotechnique générale, Prof. P. Janet, 3 vols., new edition, illustrated; La Photographie par les Procédés pigmeeutaires, J. A. Liébert, illustrated; Leçons élémentaires sur le Calcul des Probabilités, Dr. R. de Montessus, illustrated; La Télégraphie sans Fil et les Applications pratiques des Ondes électriques. Télégraphie avec conducteur. Téléphonie sans fil. Commande à distance. Prévisinn des orages. Courants de haute fréquence. Éclairage, Prof. A. Turpain, new edition, illustrated. *C. Griffin and Co., Ltd.*—An Elementary Text-book of Physics, Dr. R. W. Stewart, 4 vols., illustrated. *G. G. Harrap and Co.*—The Teaching of Arithmetic to Junior Classes, J. L. Martin; The Intermediate Arithmetic, J. L. Martin. *Longmans and Co.*—Practical Physics, L. M. Jones, illustrated; Applications of Vectors to Alternate Current Problems, C. F. Smith and W. Cramp; Introductory Mechanics, E. J. Bedford; An Introduction to Practical Mathematics, F. M. Saxelby.

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### Medical Science.

*F. Alcan* (Paris).—Traité complet des Maladies mentales, publié sous la direction du Dr. Marie, Tome i., Traité complet du Diabète, Prof. Lépine; Manuel d'Histologie pathologique, Profs. Cornil and Ranvier and Drs. Brault and Letulle, Tome iv.; Psycho-physiologie de la Douleur, Drs. J. Joteyko and M. Stefanowska. *Edward Arnold.*—Applied Physiology: a Handbook for Students of Medicine, Dr. R. Hutchison; The Body at Work, Dr. A. Hill, illustrated. *Appleton and Co.*—A Text-book of Treatment, edited by R. J. Ferguson, 3 vols.; General Surgery, E. Lexer, translated by D. Lewis; A Text-book of Minor Surgery, E. M. Foote; Materia Medica and Therapeutics, Dr. S. S. Cohen; Anatomy of the Brain and Spinal Cord, H. E. Santee, new edition; Manual of Diseases of the Ear, Nose, and Throat, J. J. Kyle. *Baillière, Tindall and Cox.*—Physiological Principles of Treatment, L. Brown; Bacteriology of the Eye, T. Axenfeld, translated by A. Macnab. *A. and C. Black.*—Tuberculosis: its Origin and Extinction, W. P. Turner. *J. and A. Churchill.*—A Dictionary of Medical Treatment, Dr. A. Latham; and new editions of The Practice of Medicine, Dr. F. J. Charteris; An Introduction to the Study of Materia Medica, Prof. H. G. Greenish; and A Manual of Bacteriology, Clinical and Applied, Prof. R. T. Hewlett. *John Lane.*—A Short Practice of Aural Surgery, for the Use of Students and Practitioners, J. A. Jones; Minor Operations. *H. K. Lewis.*—The Mind and its Disorders, Dr. W. H. B. Stoddart, illustrated; The Operative Surgery of the Ear, C. E. West and S. Scott, illustrated; The Causation of Sex, E. R. Dawson; and new editions of Vaccine Therapy and the Opsonic Method of Treatment, Dr. R. W. Allen, illustrated; and A Manual of Infectious Diseases, Dr. E. W. Goodall and the late Dr. Washbourn, illustrated. *Longmans and Co.*—A new edition of Quain's Elements of Anatomy, vol. iii., Neurology, Profs. E. A. Schäfer, F.R.S., and J. Symington, F.R.S., Part i., comprising the General Structure of the Nervous System, and the Structure of the Cerebro-spinal Axis, illustrated; An Atlas of Skiagrams, illustrating the Development of the Teeth, with Explanatory Text, Prof. J. Symington, F.R.S., and Dr. J. C. Rankin. *Macmillan and Co., Ltd.*—A System of Medicine, by many writers, edited by Sir T. Clifford Allbutt, K.C.B., F.R.S., and Dr. H. D. Rolleston, second edition, vol. iv., in two parts, Part ii., Diseases of the Ear and Throat. *Milner and Co., Ltd.*—Human Physiology, Dr. A. Wilson. *John Murray.*—Therapeutics of the Circulation, Sir T. Lauder Brunton, Bart., F.R.S.; Intracellular Enzymes, Dr. H. M. Vernon. *J. Nisbet and Co., Ltd.*—Common Affections of the Liver, Dr. W. Hale White; The Diagnosis and Treatment of Surgical Affections of the Knee, Sir W. H. Bennett; Movable Kidney, W. A. Lane; Hip Disease in the Young, J. Berry; Prostatectomy, J. W. Thomson Walker; Enuresis, J. H. Thursfield. *Kegan Paul and Co., Ltd.*—Diseases of the Ear, M. Yearsley, illustrated; The Wife as the Family Physician: a Practical Work of Reference for the Family in Health and Sickness, with Special Attention to the Care of Children, &c., Dr. A. F. Dueckelmann, translated and adapted with the collaboration of a staff of eminent physicians, illustrated. *G. P. Putnam's Sons.*—The Essentials of Dietetics, A. E. Pope; The Muscles of the Eye, L. Howe, 2 vols., illustrated; Insomnia and Nerve Strain, H. S. Upson, illustrated. *Rebman, Ltd.*—A Text-book of General Pathology, Drs. J. M. Beattie and W. E. C. Dickson, illustrated; A Text-book of Special Pathology, Drs. J. M. Beattie and W. E. C. Dickson, illustrated; A Manual of Practical X-Ray Work, Drs. D. Arthur and J. Muir, illustrated. *T. Fisher Unwin.*—Pain: its Causation and Diagnostic Significance in Internal Diseases, Dr. R. Schmidt, translated and edited by Drs. K. M. Vogel and H. Zinsser.

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### Technology.

*A. Constable and Co., Ltd.*—The Manufacture of Leather, H. G. Bennett; Textiles and their Manufacture, A. F. Barker, illustrated; The Manufacture of Paper, R. W. Sindall; Timber, J. R. Baterden; Electric Lamps, M. Solomon. *Longmans and Co.*—Lathe Design for High- and Low-speed Steels: a Treatise on the Kinematical and Dynamical Principles governing the Construction of Metal Turning Lathes, J. T. Nicolson and D. Smith, illustrated; Notes on, and Drawings of, a Four-cylinder Petrol Engine, arranged for Use in Technical and Engineering Schools, H. J. Spooner; Machine Drawing and Design for Beginners: an Introductory Work for the Use of Technical Students, H. J. Spooner; Strength of Materials, A. Morley, diagrams; A History of Architectural Development, in 3 vols., vol. ii., Mediæval, F. M. Simpson, illustrated. *Milner and Co., Ltd.*—Engineers' and Machinists' Handbook, H. A. Golding, illustrated; 2000 Trade Secrets, J. Tomlin, illustrated; Elementary Science, applied to Sanitation and Plumbers' Work, A. Herring-Shaw, illustrated. *E. and F. N. Spon, Ltd.*—The Calculation of Change Wheels for Screw-cutting on Lathes: a Practical Manual for the Use of Manufacturers, Students, and Lathemen, V. de Vries. *Whittaker and Co.*—Practical Sheet and Plate Metal Work, E. A. Atkins, illustrated.

### Miscellaneous.

*F. Alcan* (Paris).—De la Méthode dans les Sciences; Les Problèmes de la Science, Prof. Enriquez. *Edward Arnold.*—A Text-book of Experimental Psychology, Dr. C. S. Myers. *Baillière, Tindall and Cox.*—Compendium of Food Microscopy, G. E. Clayton. *George Bell and Sons.*—Elementary Experiments in Psychology, C. E. Seashore. *A. and C. Black.*—The Metaphysics of Nature, C. Read, new edition; Milk: its Nature and Composition, C. M. Aikman, new edition, illustrated; The Problem of Logic, W. R. B. Gibson, with the cooperation of A. Klein. *Blackie and Son, Ltd.*—The Universe: or the Infinitely Great and the Infinitely Little, F. A. Pouchet, new and revised edition, illustrated. *Cassell and Co., Ltd.*—The Royal Botanic Gardens, Kew, Historical and Descriptive, W. J. Bean, with an introduction by Sir W. Thiselton-Dyer, F.R.S., illustrated. *Chapman and Hall, Ltd.*—My Life: a Record of Events and Opinions, Dr. A. R. Wallace, F.R.S., new edition, illustrated. *Duckworth and Co.*—Pros and Cons of Vivisection, Dr. C. Richet. *T. N. Foulis.*—The Trout Waters of England: being a Guide to the Open English Trouting Streams and Reservoirs, W. M. Gallichan. *H. Frowde.*—Folk Memory: or, the Continuity of British Archæology, Walter Johnson; The Ethical Aspects of Evolution, W. Benett. *C. Griffin and Co., Ltd.*—A Manual of the Principles of

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## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

CAMBRIDGE.—At Emmanuel College research studentships have been awarded to members of the college as follows:—150*l*., T. H. Laby; 140*l*., R. D. Kleeman; 100*l*., H. S. Tasker.

Mr. A. R. Brown, who recently returned from the Andaman Islands, where he spent two dry seasons in studying the sociology, psychology, and religion of the pigmy inhabitants, was elected on Monday to a fellowship at Trinity College in recognition of his investigations.

In connection with the visit of the members of the Congress of Electrical Units to Cambridge on Saturday next, it is proposed to confer degrees of Doctor of Science, *honoris causa*, upon Prof. S. A. Arrhenius, Prof. G. Lippmann, Dr. S. W. Stratton, and Dr. E. G. Warburg.

Prof. Bateson will deliver an inaugural lecture in the botanical lecture-room on Friday, October 23, at 5 p.m., on "The Methods and Scope of Genetics."

Mr. G. H. Hardy, of Trinity College, and Mr. J. M. Dodds, of Peterhouse, have been nominated moderators for the year beginning May 1, 1909. Mr. A. Berry, of King's College, and Mr. G. Birtwistle, of Pembroke College, have been appointed examiners for the mathematical tripos, part i. (old regulations), for the same period.

A Grace, gratefully acknowledging the munificent gift to the University by Prof. Liveing of almost the whole of the apparatus and material belonging to him in the chemical laboratory, will be brought before the Senate to-day.

DR. CHARLES E. FAWSITT, Graham Young lecturer in metallurgical chemistry in the University of Glasgow, has been appointed professor of chemistry in the University of Sydney, N.S.W.

IN addition to the usual course of Hunterian and other lectures to be delivered during the present winter session, the council of the Royal College of Surgeons of England has arranged a series of demonstrations in the theatre of the college at which specimens from the museum will be shown and their bearing on general and surgical pathology discussed. The first demonstration of the series is to be given on Friday, October 16, at 5 p.m., by Dr. Arthur Keith. The demonstrations are open to all medical men and senior students on presentation of their cards.

ON October 7 Mr. Herbert L. Storey handed over to Lancaster the extensive buildings of the Storey Institute, which he has erected and equipped at a cost of 10,500*l*. The institute itself was the gift of the late Sir Thomas Storey, to commemorate the jubilee of the late Queen's reign. In the original building are housed the public library, art gallery, lecture theatre, and laboratories for science work. Some time ago the need for an extension was felt, and Mr. Storey offered to erect new buildings. These are now completed. The new buildings provide a workshop for manual training and a class-room for domestic science. Prof. Sadler, in an address at the ceremony, spoke of the signal value of the service which private benefactors like Mr. Herbert Storey render to public education by encouraging manual training for boys and the preparation of girls for their future duties as wives and mothers. He expressed the hope that by means of Mr. Storey's gift Lancaster may find it possible to establish a day continuation school for boys and girls of from thirteen to fifteen years of age, with a course of instruction designed to give preparation for skilled industry and for home duties.

## *SOCIETIES AND ACADEMIES.*

### LONDON.

**Royal Society**, May 21.—"On some Features in the Hereditary Transmission of the Albino Character and the Black Piebald Coat in Rats." Paper ii. By Geo. P. **Mudge**. Communicated by Prof. A. D. Waller.

These experiments show that albinoes breed true to albinism, whether their ancestry is pigmented or not. They further show that, though externally albinoes may appear to be identical with regard to their coat characters, in reality they may be different, and that some exhibit the "ghost" of the self pattern and others that of the piebald pattern. It has been previously known for both animals and plants that some albinoes carry certain colour and pattern factors, while others carry different ones, but this difference has hitherto been elucidated by means of breeding tests alone. These experiments add an ocular demonstration of the actual presence of the coat-pattern in albinoes. The interpretation placed upon the coat appearances in these albinoes is corroborated by the breeding results.

It is further shown that when a piebald black rat (Cr 5) is mated with one of a similar type, two classes of offspring may be obtained. One of these contains all black piebalds and the other a mixture of black piebalds and albinoes in nearly equal numbers.

When a piebald black rat is mated with an albino (=Cr 5×Cr 4), it may be said that, so far as these experiments have gone, five different results will be obtained. They may be stated as follows: (1) The offspring may be all black piebalds. (2) They may be a mixture of black piebalds and albinoes. (3) They may be all "Irish" forms (=a black self-coloured form). (4) They may be a mixture of albinoes, black piebalds, and "Irish." (5) They may contain albinoes, "Irish," and a grey form (=Cr 2). It can be shown that the divergency of the results obtained when two individuals apparently similar are mated is due to the gametic nature of the albino employed.

June 24.—"Preliminary Account of the Habits and Structure of the Anaspidiidæ, with Remarks on some other Fresh-water Crustacea from Tasmania." By Geoffrey **Smith**.

The paper gives an account of observations made on the habits of Anaspides in its natural state, the most important points being its method of running with the body held straight, and the deposition by the female of the fertilised eggs under stones and weeds. An account is also given of the internal anatomy, certain characters, *e.g.* the structure of the heart and of the filiform spermatozoa, suggesting affinity with the Mysidacea, while others tend towards the Decapoda, thus showing the animal to be the most generalised malacostracan known. A member of a new genus, Paranaspides, is also described, which was found in great numbers in the Great Lake of Tasmania; this animal, which bears a strong superficial likeness to Mysis, is transparent, and leads more of a swimming life than Anaspides, which it resembles in its ...tial structure, though not at all in appearance. The other members of the rich crustacean fauna of the Great Lake are referred to, and reasons are given for deriving the fauna from the lost Antarctic continent.

Received August 25.—"Further Results of the Experimental Treatment of Trypanosomiasis: being a Progress Report to a Committee of the Royal Society." By H. G. **Plimmer** and Captain H. R. **Bateman.**

The following results are a continuation of the work of which summaries have already appeared in the Proceedings of the Royal Society (B, vol. lxxix., 1907, pp. 505–16, and B, vol. lxxx., 1908, pp. 1–12) and in NATURE (October 10, 1907, vol. lxxvi., p. 607, and January 9, vol. lxxvii., p. 238). The experiments have been carried out with the same strains of nagana and surra as were used before, the average duration of untreated diseases being 5·5 and 6·9 days respectively.

*I.—Nagana Rats treated with Atoxyl and Succinimide of Mercury.*—Of these rats two lived more than 300 days, four lived more than 200 days, five lived more than 100 days, and six more than 50 days. None of the above died with any of the signs of nagana. Of the twenty-one rats tabulated only one died from trypanosomiasis, and this one was probably atoxyl-proof. One of these, which was apparently cured, was used on the 147th day after inoculation for re-inoculation, with the view of ascertaining if any immunity had been conferred. This was found not to be the case.

*II.—Nagana and Surra Rats treated with Atoxyl and Mercury Sozoiodol.*—One rat lived more than 200 days, one more than 100 days, and two more than 50 days, none of them dying from trypanosomiasis.

*III.—Nagana and Surra Rats treated with Sodium Antimonyl Tartrate.*—Nine of these rats lived for more than 200 days, and nine others considerably more than 100 days. Of those which have died only four have had recurrences, none of them died with any symptoms of trypanosomiasis, and in none were trypanosomes found after death. An emulsion of the liver and of the bone-marrow was injected into other rats in five cases, with negative results in each case.

*IV.—Further experiments.*—(A) *Nagana Rats treated with Large Doses of Sodium Antimonyl Tartrate.*—The results obtained showed that pushing the drug does not have any good effect; the trypanosomes are not driven out more quickly, or more effectually; recurrences are more common, and inflammatory intestinal lesions were present in nearly every case. Two rats died with living trypanosomes in the blood; these two had become antimony-proof, as the later doses did not remove the trypanosomes from the blood, nor make any difference in their number.

(B) *Rats treated with Sodium Antimonyl Tartrate after Inoculation with Atoxyl-proof Trypanosomes.*—It was found that the atoxyl-proof strains of trypanosomes are less influenced by antimony than are the ordinary variety, as three rats had living trypanosomes in the blood at death, and seven died at a very early date.

(C) *Rats treated with Sodium Antimonyl Tartrate and Antimony (Metal) suspended in a Fatty Medium.*—In order to make the use of antimony practicable in the form of injection, a series of experiments was undertaken, using various other media than water for solution or suspension of the antimony salt. Finally, the medium Colonel Lambkin devised, consisting of palmitin and antiseptics, which is used very largely for the intramuscular injection of mercury, was tried, and found practical. One great advantage of these preparations is that they can be used upon man with far less difficulties and after-consequences than the watery solutions, which seem to be impracticable; this is of importance should antimony be found of use in human trypanosomiasis.

Of thirteen nagana and surra rats treated with a 5 per cent. suspension of sodium antimonyl tartrate, two have lived more than 100 days, each having had only one dose, three lived more than 50 days, and none have died from trypanosomiasis.

The administration of the metal itself in a state of very fine division has a considerable effect on the trypanosomes; it has a distinctly better effect on surra than upon nagana, five surra rats out of sixteen being alive more than 200 days after inoculation, and four others having lived for a long time. In none of the surra rats were trypanosomes found at death, whereas in three of the nagana rats they were present. The metal is much more irritating than the tartrate, but the effect is in most cases more prolonged; this is probably due to the fact that the absorption of the metal is much slower. Further, the smaller doses would appear to be the most efficient.

(D) Antimony (metal) and sodium antimonyl tartrate were given before inoculation to test their effects upon the development of the disease; and the metal was found to be far more effective in delaying the appearance of the trypanosomes in the blood than the salt; this is probably due to its slower elimination. One dose of the metal given the day before inoculation delayed the appearance of the trypanosomes until the eleventh day.

(E) *Rats treated with Lithium Antimonyl Tartrate.*—There are differences in the effects produced by the potassium, sodium, and lithium antimonyl tartrates, if given under similar conditions and dosage. The sodium salt contains, roughly, about 2 per cent. more antimony than the potassium salt, and the lithium salt contains about 2 per cent. more than the sodium; but the doses of the lithium salt have to be much smaller than the corresponding doses of the sodium salt. When the watery solution is injected intramuscularly, it has not caused necrosis of the tissues in rats, but subcutaneously it has occasionally done so. The best strength of solution for rats is 0·25 per cent., and of this 0·5 c.c. has been given for a dose. Out of twelve rats five are alive and well at periods varying from 125 to 134 days. This salt is much more soluble than either the potassium or sodium compound, which may, perhaps, as well as its greater antimony content, account for its greater effectiveness.

(F) *Experiments with Antimony upon Dogs.*—In order to see what the effects of antimony would be on the larger and more important animals when suffering from trypanosomiasis, a series of experiments on dogs has been begun. The trypanosome used was that of surra, which kills dogs of about 20 lbs. in weight in approximately 14 days, as this is the trypanosome which is of practical importance with regard to dogs. Five dogs were treated at first with the suspensions mentioned under C, but we have found, since trying the lithium antimonyl tartrate, that this acts more effectually and with less irritation than the creams, whether of metal or salt. All the animals are in good condition and are gaining in weight, three at 62 days and two at 53 days after inoculation.

(G) *Experiments made with Rats treated with Antimony, in order to find out in what Organs the Trypanosomes are latent.*—Eleven rats were inoculated with nagana, which is less affected by antimony than surra, and were all treated with four doses of sodium antimonyl tartrate. The rats were killed at various intervals, and the organs selected (the liver and bone-marrow) were made into an emulsion with a minimum quantity of 0·75 per cent. salt-solution, and injected into other rats in doses of 1 c.c.; the same dose of blood from the heart was also given. In four the results were entirely negative; in three trypanosomes were found in the liver, and in six in the bone-marrow. It would appear that the bone-marrow is the place where the trypanosomes can live longest, and that the liver is also a place where they can find protection. This is borne out by some experiments we have made upon trypanosomiasis in birds, in which cultivations of trypanosomes can often be made from the bone-marrow when they cannot be made either from the organs or the blood. The doses given to the above rats were rather less than those which we should judge to be curative, but in four cases the results were entirely negative.

PARIS.

Academy of Sciences, October 5.—M. Émile Picard in in the chair.—A recent change in the aspect of the comet 1908c (Morehouse-Borrelly): G. **Bigourdan.** On September 30 the comet possessed a long visible tail, directed from the sun, and at least 15′ long. On October 1 this tail had disappeared, and the head of the comet also appeared less brilliant. Traces of a tail were noted on October 3.—The micro-organisms of intestinal putrefaction: Elie **Metchnikoff.** After reviewing the recent work on the nature and functions of the bacteria found in the normal human intestine, the author regards it as certain that the digestive tube of man contains three species of putrefactive organisms. They occur, not only in the form of spores, but also in their vegetative state of rods. The author is of opinion that the products formed by these bacteria act as poisons, and have a pathogenic *rôle*. These poisons pass through a porcelain filter, and resist the action of boiling water.—Observations of the grey tropical spot of Jupiter: José Comas **Solà.**—The convergence of continued fractions: E. **Nörlund.**—Directed waves in wireless telegraphy and the investigation of syntony: M. **Turpain.** A reclamation of priority as regards the work of MM. Bellini and Tosi and M. Slaby.—Studies on the association in series and in parallel of electrolytic detectors: M. **Jégou.** The combination of two or more electrolytic detectors in series causes a loss in sensibility, the arrangement being always less sensitive than any one of the detectors used alone. The arrangement in parallel may give results which are practically useful.—The analysis of the non-liquefiable gases in liquid air: F. **Bordas** and M. **Touplain.** The apparatus described by the author in a preceding paper for the investigation of the small quantities of gases contained in minerals has been modified to analyse the gases which escape liquefaction during the fractional distillation of liquid air. The gases used were supplied by M. Claude, and were submitted to fractional absorption by charcoal cooled to different temperatures. The spectrum of the mixture of neon and helium thus obtained is given and compared with Baly's figures.—Size of the molecules and charge of the electron: Jean **Perrin.**—The microchemical reactions of arsenic applicable in legal medicine: G. **Denigès.** The drop of the liquid containing the arsenic in the form of an arsenate is evaporated to dryness on the microscope slide, and then treated with the reagent (silver nitrate or magnesia mixture), with certain precautions described. Characteristic crystals are obtained in this way.—The active pinonic and pinic acids: Ph. **Barbier** and V. **Grignard.** The pinenes employed in this investigation were strongly active, and the corresponding acids obtained by oxidation were also strongly active in rotatory power.—The estimation of succinic acid in wines and in other fermented liquids in the presence of fixed acids: Emm. **Pozzi-Escot.**—The effect of dialysis on the ferments from plant juices: C. **Gerber.**—A young giraffe from eastern Soudan recently arrived at the museum menagerie: E. L. **Trouessart.**—A hydrological law of Minard and Belgrand: E. **Maillet.** The author's measurements lead to a slight modification of this law.

## DIARY OF SOCIETIES.

*FRIDAY*, OCTOBER 16.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Repairs, Renewals, Deterioration and Depreciation of Workshop Plant and Machinery: J. E. Darbishire.

*WEDNESDAY*, OCTOBER 21.

ROYAL MICROSCOPICAL SOCIETY, at 8.—The Mouth Parts of the Nemocera and their Relation to the other Families in Diptera; Corrections and Additions to the Paper published in 1904: W. Wesché.—(1) On the Resolution of Periodic Structures; (2) An Auxiliary Illuminating Apparatus: E. M. Nelson.

ENTOMOLOGICAL SOCIETY, at 8.—On Diaposematic Resemblances in Insects; a Reply to Mr. G. A. K. Marshall: Dr. F. A. Dixey.

*THURSDAY*, OCTOBER 22.

CHEMICAL SOCIETY, at 8.30.—The Passage of Hydrogen through a Palladium Septum, and the Pressure which it produces: D. Tsakalotos.—The Relationship of Colour and Fluorescence to Constitution, Part ii., Rhodamines of Mellitic Acid: O. Silberrad and C. S. Roy.—Constitution of the Fluorescences of Mellitic and Pyromellitic Acid: O. Silberrad.—A New Form of Gas Burette: A. E. Hill.—A Molecular Compound of Trinitroacetaminophenol and $\beta$-Naphthol: R. Meldola and J. G. Hay.—Reduction Products of Azoxybenzene, Preliminary Notice: L. H. Berry.—Constitution of the Salts of the Phthaleins, and the Cause of Colour in the Triphenylmethane Series: A. G. Green.—Chlorination of *p*-Nitraniline: B. Flürscheim.—Relation between Absorption Spectra and Chemical Constitution, Part x., Unsaturated Acids of the Benzene Series: E. C. C. Baly and K. Schaefer.—Condensations with Monochloromethyl Ether, Part i., Condensation of Monochloromethyl Ether with Ethyl Malonate and Ethyl Isopropyl Malonate: J. L. Simonsen.—Relation between Chemical Constitution and Physiological Action in Certain Substituted Aminoalkylesters: F. L. Pyman.—Effect of Constitution on the Optical Rotatory Power of Optically Active Nitrogen Compounds, Part iii.: R. W. Everatt and H. O. Jones.

*FRIDAY*, OCTOBER 23.

PHYSICAL SOCIETY (National Physical Laboratory), at 3.30.—Demonstrations of Work in Progress in the Laboratory.

## CONTENTS.

THURSDAY, OCTOBER 22, 1908.

## INDUSTRIAL HYGIENE.

*Diseases of Occupation: From the Legislative, Social, and Medical Points of View.* By Dr. Thomas Oliver. Pp. xix+427. (London: Methuen and Co., n.d.) Price 10s. 6d. net.

THE present work deals with one of the most attractive branches of preventive medicine. It is the time of legislative interference between employers and workmen, and at no time has the health of the community been held in higher regard. If the regulation of the health of workpeople is to be effected in that practical manner which has always distinguished the progress of sanitary science in this country, it is urgently necessary that those in whose hands such regulation lies should be more thoroughly conversant with the medical side of the problem.

In a comparatively small book Dr. Oliver has succeeded in bringing together a vast amount of useful information on all sorts of subjects, ranging from mining to mountain sickness and from anthrax to the alkali manufacture. The most important section, occupying nearly one-fifth of the book, is that dealing with lead poisoning, in the suppression of which in this country Dr. Oliver has played so prominent a part. Very full treatment is also given to the effects of organic and inorganic dust, a matter which has to be considered in reference to a great variety of trades. Ankylostomiasis is dealt with in detail in the light of the author's own researches, and there is a long, though not altogether satisfactory, chapter on mining.

We do not find, however, any adequate discussion of several problems which concern nearly all trades alike—the question of the temperature of factories, &c., for example—and it is certainly time that someone undertook seriously the discussion of the influence of slightly vitiated atmospheres on the health of workfolk. The subject is throughout treated almost entirely from the point of view of the medical man and the pathologist. It is to be regretted that the actual manufacturing processes are not given more fully. A proper understanding of these is necessary both for the consideration of the scientific questions involved and to enable the medical man to adjust in some part his idealism to the needs of practical life. The solution of the difficulties presented by trade diseases must at any rate begin by some sort of compromise between the manufacturer and the doctor.

Such pleasant reading do Dr. Oliver's chapters make that one may not realise at the moment that the information one has absorbed is of a peculiarly elusive kind. The facts with which he has dealt are not drawn up in any very orderly array, and throughout one finds a certain vagueness which may well tend to make the reader feel that he is treading on ground too uncertain to bear definite action. Our knowledge of industrial hygiene is sadly defective, but the general principles which must underlie preventive measures are in many cases already sufficiently well assured to bear definite enunciation. We do not suppose, for example, that Dr. Oliver really believes that there is any multiplication of individuals in Ankylostoma outside the human body; yet he leaves this absolutely fundamental question vaguely unsettled. To laymen who are not acquainted with details, and therefore not in a position to form their own conclusions, this must be very unsatisfactory.

In some places where definite directions are given they are contradictory; thus in the chapter on rescue apparatus for use in mines we find (p. 406):—"Any person attempting to do rescue work should therefore be provided with not less than 1 cubic foot of oxygen per hour"—*i.e.* less than half a litre per minute, an altogether inadequate amount—and later (p. 408):—"A man about to undertake rescue work should be given a continuous supply of 2 litres of oxygen per minute." Written by a scientific man in part at least for the use of the "general reader," we should expect to find evidence that the scientific data were stated with particular care. Yet without looking beyond the same section (p. 407) we find that "liquid air contains 2 parts of oxygen to 1 part of nitrogen," the proportions, of course, being subject to considerable variation, and "in respiration only 4 per cent. of the oxygen inhaled is taken up by the blood," instead of about 20 per cent.

The chapter on compressed-air and caisson disease is perhaps the least satisfactory. The author appears to accept the "soda-water-bottle theory," but he dallies so long with the notions that a small excess of carbonic acid in the air, mechanical repletion of the visceral veins, and frictional electricity are important factors that one is almost compelled to agree that "there is still much to learn as regards the causes of caisson disease." As a matter of fact, the work of Paul Bert, Leonard Hill and others leaves no reasonable room for doubt that the "soda-water-bottle theory" is correct. To encourage any longer the theory of Snell that carbonic acid has any material influence in practice is to stimulate local authorities to waste huge sums of money upon extravagant ventilation of caissons.

The recommendations for the prevention of caisson disease are not only indefinite, but also very unsound. Dr. Oliver considers 3 or 5 minutes per atmosphere of pressure as a safe time to allow for decompression, and quotes the experience at the Bakerloo tunnel that the cases of illness were not diminished by extending the time of decompression from $1\frac{3}{4}$ to $6\frac{1}{2}$ minutes. The truth is that all these times are so much too short that one is not likely to be much better than another; some 30 to 60 minutes are required for real safety. Dr. Oliver commends, but fortunately does not detail, the Dutch regulations; these, in fact, prescribe that the rate of decompression should become quicker as the pressure falls, a procedure which, if applied to decompression from high pressures, would without doubt kill many people. In the pages devoted to diving, he states that divers should descend slowly; he does not explain why, perhaps because there is no reason except that a slow descent increases the risk.

The whole subject of trade diseases is in fact too large and too complicated to be handled by a single author, and it cannot be dealt with in generalities. The facts are difficult to come by and hard to interpret, yet it is upon accurate detail alone that preventive measures, involving as they may do such large interests, may with propriety be undertaken. Dr. Oliver has provided a very pleasant introduction to the subject, which should at any rate tend to promote cordial relations with his Continental confreres.

A. E. B.

## SCIENTIFIC EXPLORATION IN DAHOMEY.

*Mission scientifique au Dahomey.* By Henry Hubert. Pp. iv+568. (Paris: E. Larose, 1908.) Price 15 francs.

IN this work M. Hubert gives a very detailed description of the results of his various journeys in Dahomey, dealing principally with the meteorology, the action of surface waters and of the sea, and the geology. The volume is accompanied by an admirable geological map on the scale of 1 : 1,250,000, giving the broad structural features of the colony as far as Sansan-Haoussa, on the Niger, in approximately 14° N. lat. It is, of course, idle to expect entirely satisfactory conclusions at a comparatively early stage of investigation, but there is every reason to congratulate M. Hubert on the volume he has produced, on which much time and care have been lavished, and which constitutes a great advance in our knowledge of West African geology. M. Hubert mentions at the outset the characteristics well known to geologists on that coast, of a general simplicity of the main features, a complication in detail and a woeful scarcity of fossils.

As was already known, crystalline rocks occupy by far the greater part of Dahomey, and the coarse granitoid gneisses, banded gneisses, mica- and hornblende-schists, granites and pegmatites do not greatly differ from those of Kamerun and southern Nigeria.

Amongst the less common rock-types described may be mentioned an alkali-granite containing riebeckite, recalling the similar rocks described from Zinder and south of Chad; and some cipolins from the bed of the Zon (Savaloo region), associated at Zompa with a scapolite-hornblende-gneiss. In a somewhat brief account of the petrography these cipolins are described as containing diopside, forsterite and calcite, the first and second occasionally altered into antigorite.

Omitting for a moment the recent beds, M. Hubert finds the continuity of this great stretch of crystalline rocks is broken twice; first by the quartzites of the Atacora ridge, and secondly by the grits of the Gourma. The Atacora range traverses the colony obliquely from Kirtachi, on the Niger, to about the tenth parallel; and is, in M. Hubert's opinion, a prolongation of the northern and southern range, forming the central part of Togo Land, which twists south-westwards to reach the sea at Accra.

Additional information concerning the relations of the Atacora quartzites to the underlying gneiss and mica-schists would have been welcome, and we may incidentally remark that the word quartzite is used throughout the book for somewhat dissimilar rocks. The Atacora quartzites are probably quartz-schists, and when disturbed (they are generally horizontal) are folded with the underlying rocks. On very slender evidence M. Hubert provisionally maps these rocks as Silurian.

The Gourma grits occupy a tract of country much smaller than, but mapped as essentially parallel to, the Atacora range. The rocks extend from Kodjar to a point more than 100 kilometres south-westwards. These Gourma grits are surrounded by crystalline rocks, noteworthy for the abundance of basic types, both amongst the schists and the eruptive series. In regard to age M. Hubert places these grits between the Atacora quartzites and the far more recent beds of the Niger basin, considering them nearer to the former than to the latter.

It is interesting to note the resemblance they bear to the Bandiagara and Hombori beds recorded by M. Desplanges.

Between the Gourma grits and the alluvium, "*terre de barre*," and other deposits now in process of formation, two areas are noteworthy as containing comparatively recent beds, and as helping towards a reconstruction of West African geography in late Cretaceous and Tertiary times. These are the grits of the Niger basin and the calcareous beds of Lama, which form a narrow strip crossing the colony obliquely to the south of Abomey in 7° N. lat. The ages of these deposits are not definitely fixed; the Niger beds are unfortunately unfossiliferous, and the fossils of the Lama region are not sufficiently characteristic to allow the Eocene age, suggested for them, absolutely to be proved. The identification is based on the occurrence of a Turitella, near to *T. eschi,* which in Kamerun is associated with undoubted Eocene fossils, and on the occurrence of *Dactylopora cylindracea,* Lamk. A photograph of a specimen of the shelly limestone and the general habit of the beds recalls the (? Upper) Cretaceous beds of the eastern province of southern Nigeria, and it appears at least possible that future investigation may show the Dahomey rocks to be rather older than was at first believed.

The very interesting question of the age of the Niger grits has to be left entirely open. They form the plateau on either side of the river between Sansan-Haoussa and Gaya, and have been cut through by the Niger, which thus exposes the crystalline rocks beneath. M. Hubert notices these beds as occurring as far south as Sakassi, in northern Nigeria, and somewhat similar rocks occur on the Jebba-Lokoja section of the river. Is it possible that these beds also are of Cretaceous age?

Nearly one-third of the book is devoted to a discussion of the meteorology and the action of superficial waters, while a few short chapters are concerned with the distribution of animal and vegetable types. Distribution of races as determined by geographical conditions greatly interests M. Hubert, and the all too short notice he gives of the ethnography of the country is concerned with this question. Space only allows of the conclusions at which he arrives being given.

After noting the greater density of the population in the southern part of the colony, a result partly of the forcing seawards of the people by repeated migrations from the north, and partly of the exceptional fertility of the ground; he sums up rather unexpectedly for the remainder of the colony by saying, "tandis que les grandes rivières de l'intérieur font l'office de pôles répulsifs de la population, les montagnes ont été au contraire des pôles attractifs."

The book is essentially one for the geologist, and, if in some places the amount of detail given appears almost too great, we have in M. Hubert's work a most comprehensive and valuable description of an important West Coast colony.

In view of what M. Hubert has been able to do for Dahomey, and Drs. Esch, Solger, and others for Kamerun, it is somewhat dispiriting to find a less keen interest taken by geologists in England in regard to the investigation of the not insignificant British colonies and dependencies. J. P.

## THE SOLAR SYSTEM.

*The Solar System. A Study of Recent Observations.* By Charles Lane Poor. Pp. x+310; illustrated. (London: John Murray, 1908.) Price 6*s.* net.

IN putting into book form his lectures at the Columbia University, Prof. Poor has rendered a great service to those serious students who, unequipped with a technical vocabulary and a knowledge of mathematics, yet desire to become acquainted with our present-day knowledge of the solar system.

The book is distinctly different from the majority of astronomical text-books in respect to the relative importance attached to the various parts of the subject. Prof. Poor's lectures were evidently intended to supplement the available text-books, and difficult matters, generally given but brief notice, are treated more fully and so clearly that the general reader will find them now well within his limits. This characteristic of the book is noticeable from the beginning, where the author discusses the moon and the alleged variations of lunar features, the earth as an astronomical body, and the tides. The figure and mass of the earth, and their determination, the variation of gravity with latitude, the modifications undergone by the luni-solar tide ere it produces the effects seen round various coasts, and similar subjects are treated comparatively fully.

In the descriptions of the various attempts to measure the solar parallax (chapter iv.), the author refers to the 1900 observations of Eros as likely to afford trustworthy values, but does not appear to have included the preliminary results which have accrued from the Greenwich and Cambridge campaigns.

The chapter on the physical characteristics of the sun is more conventional in its treatment, the history, nature, and changes of sun-spots being discussed at some length. A striking illustration of the variation with latitude of the solar rotation is provided in the brief description of the relative displacement of land-masses which would follow did the earth but exhibit the same mobility; in a few days from the commencement of a rotation, South America would have displaced South Africa, whilst Sumatra would be directly south of New York. The explanation of the Lockyer-Janssen method of observing solar prominences leads up to the more recent photographic application of the principle in the spectroheliograph, and several of the Yerkes results are reproduced.

The brief descriptions of the instruments and methods whereby the sun's light and heat have been determined are especially clear, and should give every reader a very fair idea of the results achieved by the beautiful researches of Pouillet, Crova, Violle, Langley, and Abbot.

In the succeeding chapters the planets are discussed, first generally, as to their apparent motions, mutual attractions, &c., then *seriatim*. The relative certainty with which their various markings have been established is treated at some length, and some of the conclusions arrived at by Prof. Lowell come in for sharp criticism. But it must here be remarked that that observer has himself stated that the Venus markings are not so hard or regular, or so Martian in their appearance, as they were at first reported to be, whilst many of the theoretical arguments against, and practical negations of, the presence of water vapour in the Martian atmosphere will avail little against the spectroscopic evidence obtained at the Lowell Observatory by Mr. Slipher (see NATURE, No. 2002, March 12, p. 442) since this book was written.

The present-day rapid march of astronomical discovery is further illustrated in the chapter (xii.) on satellite systems, in which the author recounts the discoveries of three new satellites in as many years; yet the tale is incomplete, for, naturally, J viii is not in the list. After a chapter on comets and meteors, the book fittingly concludes with one on the evolution of the solar system, in which the author, after taking a brief historical survey of the various hypotheses, shows how the planetesimal-spiral hypothesis of Chamberlin and Moulton may be held to explain most satisfactorily the many, and sometimes apparently inconsistent, phenomena observed.

The volume is beautifully printed and illustrated, whilst its freedom from slips shows that the author has exercised the same minute care over the proofs that he has in the selection and exposition of the matter. WILLIAM E. ROLSTON.

## OUR BOOK SHELF.

*Handbuch der Pharmakognosie.* By Prof. A. Tschirch. Part i. (Leipzig: Chr. Herm. Tauchnitz, 1908.) To be completed in about 30 parts at 2 marks (2*s.*) each.

DURING the past twenty-five years there has been no lack, in Europe or in the United States, of text-books of pharmacognosy, most of which have been designed to meet the requirements of limited circles of students, and have doubtless more or less efficiently served their purpose. But Prof. Tschirch intends his handbook of pharmacognosy to be a work of different character from any of these, of wider scope and higher aims, extending and deepening the scientific foundations of pharmacognosy, a field upon which Prof. Tschirch, assisted by his numerous pupils, has laboured for many years.

The author divides the subject-matter into general (or scientific) and special (or applied) pharmacognosy, and rightly insists that the former should be studied under a capable teacher at a properly equipped institution. General pharmacognosy is subdivided into two sections, the first of which deals with the problems of pharmacognosy, with the cultivation, commerce, history, and study of drugs, while the second treats of the sciences of botany, chemistry, zoology, physics, geography, history, &c., in so far as they directly relate to pharmacognosy. In the second subdivision of the work, viz. special pharmacognosy, each drug will be described separately, and, judging from the specimen issued with the first part, in the fullest conceivable manner, each account being a complete monograph of the drug. The grouping of these monographs is to be based upon the chemical relationship of the active constituents of the drugs which, it is hoped, will form a natural bridge to their therapeutical uses.

Comparing the scheme of the work with the plan of a classical English work on the same subject, the "Pharmacographia" of Flückiger and Hanbury, it will be seen that the chief differences lie in the separate treatment of general and special pharmacognosy, in the endeavour to base the grouping upon the chemical constituents, in the greater detail and in the extreme richness of illustration.

That the handbook of pharmacognosy will be one of the most voluminous and one of the most important works that has ever been produced on the subject cannot be doubted. The author's profound acquaintance with the anatomy of drugs is a guarantee that each description of the structure of a drug will be a masterpiece. The chemistry of drugs has also received his continuous attention for years; but whether our knowledge of their active constituents is sufficiently extensive to allow of the proposed classification being satisfactorily accomplished remains to be seen. The work contains the promise of rich stores of information, of abundant literary references, and of admirable illustration that will be invaluable to all who are interested directly or indirectly in crude drugs. Henry G. Greenish.

*Memories of Dr. E. Symes-Thompson, a Follower of St. Luke.* By his Wife. Pp. vii+195. (London: Elliot Stock, 1908.) Price 3*s.* 6*d.*

The life of every physician who has attained and held for many years an acknowledged place in his profession necessarily includes in its scope something beyond his daily medical work. Some, like Sir S. Wilks and Gairdner in this country and Trousseu and Charcot in France, have left behind them a large addition to medical science, although now, with increased knowledge and specialisation, the clinician leaves a large part of the scientific field to others. Some, like Sir A. Clark, have been great teachers and public leaders in medicine; and others, again, without much of public recognition, have brought a detached and philosophic mind to bear on the problems of life and disease—and their teachings have exerted profound influence.

Dr. Symes-Thompson belongs to yet another class. A man of great industry, with ready insight and quick sympathy, the *practice* of medicine was his forte. To this it must be added that he was an earnest Churchman and one of the founders and a Provost of the Guild of St. Luke, and that he was possessed of an energy and rare social gifts which gave him a leading place in every cause that he espoused. He was for many years physician to the Brompton Hospital for Diseases of the Chest, and was one of the first authorities upon the effects of climate in the treatment of consumption, and contributed many valuable observations upon the influence of climates upon chronic disease.

As professor of physic at Gresham College for a long term of years, he assisted in that extension and popularisation of medical knowledge which in this country has accompanied the advance of education. Dr. Symes-Thompson will also be remembered as a leader in life-assurance medicine. He succeeded in gaining the confidence of the lay authorities in life assurance, and did much to advance our knowledge in this branch of medicine.

The present volume of "Memories," recently published by his wife, gives a charming account of Dr. Thompson's personal and family life, in London and at his country house. It includes also many tributes of affection from colleagues and old friends, and cannot fail to be of interest to the large number of persons who were brought into contact with him.

*Wax Craft: All about Beeswax. Its History, Production, Adulteration, and Commercial Value.* By T. W. Cowan. Pp. 172. (London: Sampson Low, Marston and Co., and *British Bee Journal* Office, 1908.) Price 2*s.* net.

Between theology and bee-keeping there is apparently little connection. Yet whilst Luther and Zwingli were compassing the downfall of a Church, they were also preparing hardship for a rural industry. With the decline of Roman ritual the demand for candles and tapers slackened, and as a consequence the sellers of beeswax, whatever their religious leanings, had at least financial reason to mourn the advent of the Reformation.

Mr. Cowan touches on this and other historical matters in the introduction to his little book, which is devoted to a general description of beeswax. The secretion of the wax and the methods of "rendering" it are fully described, several illustrations of extractors and presses being given, with hints upon the best modes of manipulation. Refining and bleaching processes; the making of comb-foundation; distinctions between commercial varieties of wax; methods of adulteration and analysis, and the applications of beeswax in commerce, are all dealt with in turn; and the book concludes with a collection of technical recipes.

In some of the sections the treatment is too sketchy to be of much value to the technical reader. For instance, the chapters on the adulteration of beeswax and on the manufacture of wax flowers would not greatly assist the analyst or the modeller. Moreover, outside his own immediate province the author is not always a trustworthy guide—as witness the statement (p. 110) that paraffin wax is obtained by the distillation of naphtha. But the book as a whole is a useful one for bee-keepers, and is generally interesting. C. S

*Educational Wood-Working for School and Home.* By Joseph C. Park. Pp. xiii+310. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1908.) Price 4*s.* 6*d.* net.

This book is intended primarily for use in the public schools of America, and it indicates for English readers to what extent manual training enters into the curriculum of such schools, and how the training in this branch of work is carried out. The book is divided into seven parts or chapters, which deal respectively with the following subjects:—(1) The enumeration, description, and illustration of woodworking tools, such as benches, squares, chisels, saws, planes, brace and bits, &c.; (2) woodworking machinery, including band and circular saws, wood-planers, and wood-working lathes; (3) the classification, description, and properties of various woods; (4) fastenings, such as nails, screws, glue, dowels, cleats, &c.; (5) the finishing of wood surfaces by paints, stains, polishes, and varnishes; (6) in this part we have a graduated set of examples, with dimensioned drawings, of suitable objects to be made at the bench, beginning with simple knife-work and ending with a combination desk and bookcase; and in (7) instruction is given in wood turning, with examples for practice. There are three appendixes giving some problems in practical geometry, some useful tables and instructions, and a key for the identification of all the principal woods of North America.

As will be seen from the foregoing, the book is intended to be used under the direction of a skilled workman, who is responsible for giving instruction in the proper handling and manipulation of the tools. Teachers in this country will be well advised in consulting this excellent text-book.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

### On the Change of Colour in the Eyes of an Attis Spider.

On Saturday, September 5, I found a small spider with light green, transparent legs and brown body with silver flutings. I bottled it quickly, and hurried up to my friend Mr. Strickland, and on examining it there under a magnifying glass observed a frequent change of colour in its eyes. I took it home, and on examining it for about six hours consecutively found it to have the faculty of changing the colour of its eyes at its own free will. In an instant it changed the honey-coloured eyes into shining black. While it changes the eyes, a bright dot or streak appears and vanishes all at once.

I am quite sure that the animal actually changed something inside the eyes. The cornea—as one may call it—is circular. The two corneas stand in a vertical plane so that they face the observer like a pair of gig-lamps, or, still better, as those in front of a railway locomotive. Behind each cornea is a conical sack, in shape much like an ordinary butterfly-net or a jelly bag. Taken together with the cones, the pair of eyes look like a pair of field glasses. The spider was found to wag the conical portion of the eyes every now and then. Fortunately, the head in this species being translucent, the mechanism by which the colour-change is effected can be easily seen by means of a good pocket lens. The spider itself was 6 mm. in length, and its conical eye one millimetre.

I put the spider in a small, thin, clean test-tube, and stopped the mouth of the tube with a little bit of cotton-wool. Having done this, I took the tube to a powerful table lamp and examined it with a pocket lens in that light against a white background. A thin strip of white paper serves very well as a background. When I first took it near the light the spider seemed to be startled and ran about. It was at this moment that I saw it wagging the conical part of the eye all the more. The spider ran a few paces, then stopped, and began moving the eyes very vigorously. On closer examination I found that the outer and larger end of the cone was a transparent honey colour. The inner tapering portion of the cone was jet black. The light and black halves were divided by a well-marked ring. The change in the colour of the eye is caused—as will be explained immediately—by the wagging to and fro of the two posterior cones. Reference to the diagram will show that the cones can be in such a position (A, A) that their axes are parallel to one another and in the line of sight of the spectator facing the cornea, or they can converge to a point just halfway between the two eyes in question (B, B), or the axis of one eye may converge while that of the other will remain unchanged. It is to be observed that the apices of the cones never diverge.

Roughly speaking, the black extends only one-third of the whole length of the cone from their tips. Consequently,

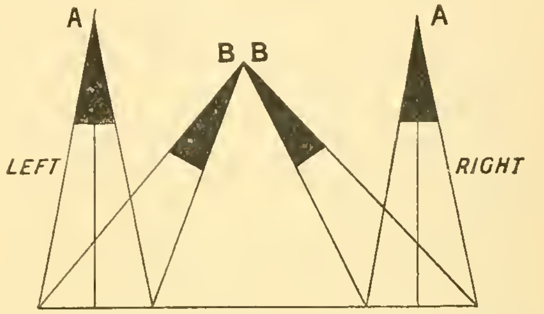


Fig. 1.—(1) Position A, A. Both the eyes of the spider now appear black, because the line of sight plunges into the black portion of the cone. (2) Position B, B. Both the eyes now appear honey-coloured, because both lines of sight cut the honey-coloured parts of the cones. (3) Position A (right), B (left). The right eye will appear black, the left honey-coloured.

when the spectator faces the eyes, and the axes of the cones are parallel, he sees into the depths of the two cones, and the eyes necessarily appear jet black. When the two tips of the cones converge the line of sight strikes the honey-coloured outer portion of the cones, and then the eyes in consequence appear honey-coloured. Lastly, the spider has the power to cause the tip of only one cone to converge inward, and then only that eye appears honey-coloured, while the other one remains black. It has been stated above that when the spider changes the colour of the eye a bright line or dot traverses the cornea. This is due to the ring formed where the black and honey-coloured portions of the cones unite traversing the cornea as the colour of the eye changes from light to dark, and *vice versâ*. It must be well borne in mind that in all these cases the cornea of the eye remains perfectly unchanged and immobile, the change of colour being wholly and entirely due to the movement of the cones behind it.

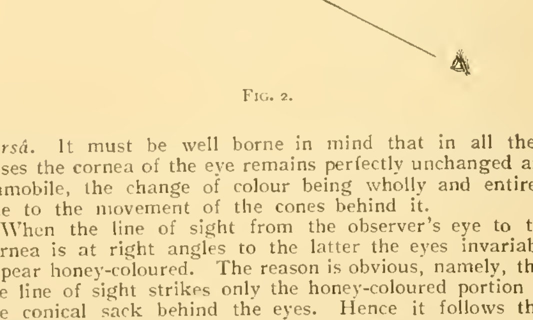

Fig. 2.

When the line of sight from the observer's eye to the cornea is at right angles to the latter the eyes invariably appear honey-coloured. The reason is obvious, namely, that the line of sight strikes only the honey-coloured portion of the conical sack behind the eyes. Hence it follows that the axis of the cones must be either above or below the line of sight. But as a matter of fact it is above it. The proof of this is that if you look at the eyes a little from below they appear black, whereas if you look at them from above they still remain honey-coloured. The accompanying diagram (Fig. 2) shows to demonstration that this can only be the case if the cones lie on an inclined plane with the apices a little above the plane which divides the cornea horizontally into two equal halves.

Thus the simple mechanism by means of which the change of colour is controlled by the spider (in at least six species of spiders, and most likely in many others) has been satisfactorily explained.

T. Padmanabha Pillai.

A. V. Lodge, Main Road, Trevandrum, Travancore, India.

### Meteorology of the Indian Ocean.

The immortal Bacon laid it down as an axiom that the scientific man loveth truth more than his theory. Let this serve me as an apology for trespassing on your space. In Nature of September 17 there appeared an interesting review of a work by the Netherlands Meteorological Institute, dealing with the meteorology of the Indian Ocean, which appears to me deserving of comment. Your reviewer says that the data therein are made available "for the sailor and the meteorologist." Permit me to suggest that this statement is unfair to the sailor. Every shipmaster is perforce a meteorologist, but every meteorologist is not a shipmaster. Much, however, depends upon what is meant by the ink-horn term "meteorologist," and it is necessary to define our terms before proceeding to argument.

The reviewer credits the Netherlands authorities with having omitted from their charts "unnecessary details or results of doubtful utility," including fog. I would submit that information with respect to fog probability is both necessary and useful for seafarers. Some shipmasters might stoutly assert that such information is to be preferred before average isobars. Rain gauges are not usually carried on board ship, and to calculate humidity from the large majority of the wet- and dry-bulb observations taken at sea would be but to court confusion. The readings of rain gauges and of wet bulbs on board ships under way are often destitute of scientific value by reason of the environment. Hence, in my opinion, the Netherlands charts gain in quality by the decrease of quantity under those heads.

The reviewer emphasises the contention that the average sea-surface current, in regions where the wind is fairly constant in direction, flows to the left of the average direction of the surface wind in the southern hemisphere. Surely such deviation is merely apparent! Current charts of the several nations differ *inter se*. Perhaps too much has been made of the effect of the earth's rotation on the direction of the surface wind, and your reviewer pushes the theory off the solid ground of nature. With one dip of ink the meteorologist dwells on cyclonic indraught and anticyclonic outdraught as though the earth were at rest, and with the next dip he fixes our attention solely on the rotation of the earth, to the utter exclusion of indraught and outdraught. One thing is certain. Had the reviewer helped to make ocean currents by faulty steering, or dealt with the current data in ships' log-books, it is probable that he would be chary of making any hasty generalisation even though it appear to agree with Nansen's drift or Ekman's theory. I seem to remember that serious objections to the geographical positions of the former remain uncontroverted.

Many of the so-called currents used in the compilation of the Netherlands charts are open to re-consideration. On p. 11, for example, the components of three alleged currents are +5 and −6, with a resultant of 2·6 miles in twenty-four hours. Either the currents were insignificant or they were contradictory. Had every difference between a ship's position by observation and by dead reckoning, which gave a resultant of five miles or less, been regarded by the compilers as "no current," as is usual in this country, a large proportion of the Netherlands current resultants must have suffered modification. Errors in steering, variation, deviation, leeway, distance run, and other items which are known to the sailor, are all dumped into the dead reckoning position, and even the position by observation of a heavenly body is not free from imperfection. Moreover, the seaman has a way of his own in keeping a log-book, and unless the log-books used by the Netherlands authorities were first carefully examined by nautical experts, the results obtained are probably misleading. The sea is full of secrets, and, as Longfellow sang, "only those who brave its dangers, comprehend its mystery."

The reviewer says that in the pressure charts not only the average isobars are drawn, but also the average pressure for each two-degree area is inserted; but I fail to follow his explanation of the latter innovation. Small departures from the normal barometer values in the tropics may be, as he suggests, monitors of an approaching cyclonic disturbance, but, depend upon it, the seaman pays far more attention to the action of his barometer, as regards interference with diurnal range, for example, at the instant. Granting your reviewer's argument to be sound, there does not appear to be any logical connection between it and the erratic differences of the individual means on the charts from the isobars. The Netherlands observations, as is evident from previous publications, are on zones which join the Cape with Sunda Strait and Perim with Acheh Head. Elsewhere the results are on an unsatisfactory foundation. In one two-degree area, for example, there may be a discontinuous series of six observations, in 1856, 1886, 1887, 1897, 1903, and 1904, respectively, nearly all of gale force; and in the adjacent rectangle six times as many observations, all in one year, from a single ship detained by light winds and calms. This explains the fallacy involved in the reviewer's inference.

Dr. Shaw, F.R.S., in his address at the British Association gathering in Dublin, pathetically referred to the ever rising tide of meteorological literature, and many are overwhelmed by it. Byron has well said that "a man must serve his time to every trade, save censure, critics all are ready made," but the above remarks are written to elicit the truth, and a long apprenticeship has been served by me in marine meteorology.

Wm. Allingham.

"Saratoga," Clairview Road, Streatham, October 3.

Mr. Allingham submits that information with respect to fog probability is both useful and necessary to the seafarer. I do not deny the usefulness; what I implied was that in the present state of meteorology no adequate information of fog probability could have been conveyed to sailors by making charts of fog from the observations for the region under consideration. The charts showed the northern limit of the region in which the sailor might expect fogs, and this was stated in my article.

I was aware of the fact that rain gauges were not usually carried on board ship, and that observations of the wet-bulb were not always made with the carefulness and precision necessary for humidity calculations. It was to stimulate interest in these important meteorological elements that I remarked on their absence from an important publication. It is not impossible to obtain really useful results for rainfall and humidity by observations made at sea.

With regard to the ocean currents, I was directing attention to a point worthy of further investigation. I did not push the theory anywhere. I commented on the fact, obvious on a comparison of the charts, that the wind and current were related in the way indicated by Ekman's theory.

It is useless for Mr. Allingham to attempt, by directing attention to the large and well-known possible errors of a single observation, to abolish the cumulative evidence of a long series of observations over a large part of the ocean surface. I made no hasty generalisation. The deviation of the current in the Indian Ocean to the left of the S.E. trade wind and of the W. to W.N.W. wind of higher southern latitudes is a real deviation.

The insertion of the mean value of the barometer reading was not intended to supplant the sailor's knowledge of the effect of diurnal variation or any other effect that would enable him to make a good forecast, but to supplement it. Its value is not destroyed by the existence of errors in some of the mean values.

E. Gold.

## SOME CROMLECHS IN NORTH WALES.

### I.

IN a recent number of NATURE the Rev. J. Griffith, the acting secretary of the Society for the Astronomical Study of Ancient Stone Monuments in Wales, gave the detailed results of some recent measurements of cromlechs in Anglesey and Carnarvonshire.

FIG. 1.—The May-year Cromlechs at Plas Newydd.

I propose in the present article to refer to some general questions in relation to them.

In the first place, I may point out that it is not a little remarkable that all the cromlechs, which were taken at random—ease of getting at them being the only principle of selection adopted—fell into line; by which I mean that all the directions indicated were the same as those which had already been made out in Cornwall. With regard to the solar alignments, indications were found of observations of the May-year sun (dec. 16° 20′ N. and S.), of both solstices and of the equinox. I have already given curves (*ante*, p. 572) which show how closely the measures fit the computed azimuths in the latitude of Anglesey (53° N.), when the heights of the horizon are taken into account. Two things, however, have to be stated: First the observations were made with a clino-compass only, and many of them in a high wind and snowstorm, which made the measures very uncertain. The next point is one of more general interest. In Cornwall and elsewhere evidence is rapidly accumulating that the solstitial alignments were not made so frequently on the actual place of sunrise as on a point somewhere about a degree south of it for the summer solstice, and north of it for the winter solstice, so that warning of the coming event could be given, and a careful watch kept. It will be seen that the majority of the alignments now in question fulfil these conditions. If we assume that the cromlechs were erected about 1000 B.C., the sun's declination then was N. 23° 50′, according to Stockwell. The only exception is at Presaddfed, at which cromlech only an estimate of the azimuth was possible, as there were no surfaces to measure.

One interesting point connected with this practice of warning is that it explains the azimuth of the Friar's Heel at Stonehenge in relation to the avenue.

Mr. Thomas recently found that the practice was adopted in regard to three or more alignments connected with the Tregaseal circle in Cornwall.

The most massive cromlechs with large quoits supported by tremendous upright stones are connected with the May year; first among these come the double cromlech at Plas Newydd; and reasoning from what one has seen in Cornwall and South Wales of the different methods of building, they are the most ancient structures I have observed in North Wales. On the other hand, the equinoctial cromlechs, supported by horizontal layers or small stones, are the newest.

*Photo. by Lady Lockyer.*

FIG. 2.—The Equinoctial (? late) Cromlech at Lligwy.

Between these two sets come the solstitial cromlechs. Of them I give three illustrations showing greatly varying types. Of them all Byrn Celli Ddu is the most interesting, as there is a long *allée couverte* or creep-way, which is exceptional in Britain, so far as "cromlechs" go, though many may be still hidden in "long barrows" such as New Grange,

*Photo. by Lady Lockyer.*

FIG. 3.—Bryn Celli Ddu (Summer Solstice), view looking S.W.

which, so far as I can make out, is oriented to the Winter Solstice. It is fortunate for students that the state of dilapidation of Bryn Celli Ddu just shows the earth of the barrow gone and many of the stones of the creep-way still *in situ*.

Mr. Neil Baynes, who has made a careful study of this monument and the literature connected with it, has been good enough to send me the plan of it, copied from the "Archæologia Cambrensis," in which the orientation is 35° out. He writes:—"The plan *was* made by Lukis, but I do not know who twisted it into the Arch. Cam.—certainly the arrow showing north was not Lukis'.

"The plan shows the creepway parallel with the S.E. stone, which was evidently the first set up, and the subsequent arrangement of the other stones. One can see how the second stone overlapped the first, and so on, until the entrance was reached."

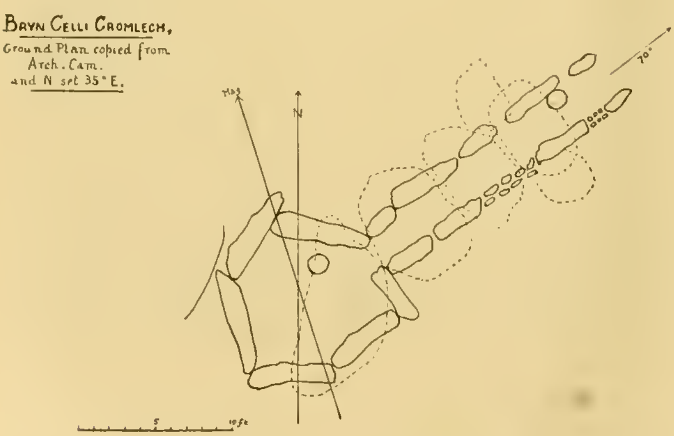


FIG. 4.—Plan of Bryn Celli Ddu, showing the true solstitial alignment of the S.E. stone and the creepway.

There is a feature on this cromlech of great interest. It consists of a cylindrical pillar shown on the plan. There can be no doubt, I think, that it once stood in the fairway of the *allée couverte* for the light to fall upon at the solstice—a kind of echo of the Egyptian ceremonial of the "Manifestation of Ra," the cylindrical stone replacing the statue of the god. Here we have one case out of many which might be named which suggests that what may be called the *furniture* of cromlechs is worthy of a close comparative study.

The cylindrical stone now in question seems to be the counterpart of other stones located in a similar way observed in other cromlechs. Borlase, in his account of New Grange,[1] writes as follows:—

"I am inclined to think . . . that we may accept as true the statement of Molyneux, that a 'slender quarry-stone, 5 or 6 feet long, shaped like a pyramid,' lay along the middle of the cave in the spot in which it is placed in his plan, and that his surmise is probably correct that it once stood upright. My view on this point is strengthened by the fact that a pyramidal pillar, shaped and rounded, was found standing upright within the chamber of the dolmen of Yr Ogof,

FIG. 5.—Cefn Isaf (Winter Solstice).

in Wales (see Archæol. Camb., 1869, p. 140), which in form closely resembled the pillar-stone called the Bod Fergusa, at Temair. Such a stone could readily have been removed through the passage, and its shape, so suitable for a gate-post or for building purposes, would supply the special motive for its abstraction."

Borlase (p. 450) gives a plan of Yr Ogof showing that that name is a variant of Bryn Celli Ddu. He also states that the plan was made in 1869 by a Captain Lukis, and therefore not by the Rev. W. C. Lukis, to whose accurate work in Cornwall I have on previous occasions directed attention.

In the plan of a "cairn" (L), at Lough Crew, given by Borlase on p. 325, another similar pillar is shown prostrate, but occupying the same position in the cromlech as the cylindrical pillar of Bryn Celli Ddu.

Another similar pillar is also suggested by the plan of the *allée couverte* at Mané Lud given by Borlase on p. 450.

Cefn Isaf—another solstitial cromlech—is to me

[1] "Dolmens of Ireland," p. 355.

very suggestive; it is to be regretted that one of the supporters has gone; with it in position and the quoit removed we have a great similarity to the leading feature in the Aberdeen circles, namely, a recumbent stone between two uprights. The similarity to a cove is also obvious.

NORMAN LOCKYER.

## HELIUM.

A LITTLE more than ten years ago this remarkable element was only known to astronomers through the medium of the spectroscope. Now it is not only to be found in all laboratories, but appears to occur in almost all constituents of the earth's crust and in amounts proportional to their radio-activity, except in beryl (Strutt). In some cases it occurs in quantities far from minute, as in certain minerals, particularly cleveite and monazite, where the number of litres of gas obtained is comparable with the number of kilograms of mineral treated. Again, it constitutes more than 5 per cent. of the gases evolved from some mineral springs, as at Maizières, and 1·84 per cent. of the vast supplies of natural gas at Dexter, Kansas, while it occurs everywhere as four parts in a million of the atmosphere (Ramsay). Its mode of occurrence and origin are too complex and still too uncertain to be treated adequately here, but it is apparently not liberated from minerals by grinding alone to an impalpable powder (Moss), and it certainly permeates quartz at temperatures above 220° C., and with a velocity rising with the temperature (Jaquerod and Perrot). Moreover, it appears to be frequently produced in the gradual breaking down of the uranium molecule and the various radio-active transformations of this into radium and other substances.

Helium was first known from its yellow line $D_3$, and was first detected on the earth by the same characteristic (Ramsay). In nitrogen or hydrogen it appears that a proportion of 10 per cent. can just be detected by its spectrum (Collie and Ramsay). Very shortly it was shown to be a very light, unreactive gas with monatomic molecules. Hence it was taken to be the lightest known member of the argon group. Later determinations have shown that its density cannot differ much from 2·0 (Onnes), and that the value of the ratio of its specific heats is 1·63 (Geiger), which confirms the earlier results.

The very simple character and small mass of the molecule are evident in all its properties; thus its refractivity $(n-1)$ is found to be very small, but various observers differ as to whether there is dispersion in the visible spectrum or not. Recent results give values of $3·478 \times 10^{-5} + 7·6 \times 10^{-16}/\lambda^2$ (Burton), and $3·47 \times 10^{-5} + 8·2 \times 10^{-16}/\lambda^2$ (Cuthbertson and Metcalfe), in excellent agreement for a value about one-quarter of that of hydrogen and with considerable dispersion. Measurements on the conductivity for heat $K = f\eta C_v$ show that it is greater than for other gases, and appear to indicate that $f$ has its theoretical value of 2·5. They are, however, complicated by the uncertainty as to the value of $\eta$, the viscosity. The viscosity with reference to air is given as 0.96 (Rayleigh). The diffusion of helium through a porous plug is faster than the simple theory would indicate (Ramsay and Collie), and this, together with the want of conformity in effusion results, may be partially due to its very low inversion temperature (Donnan).

The same characters are obtained under the influence of electric stimulus; thus ionic velocities of 6·31 cm./sec. for negative and 5·09 for positive $\alpha$ rays (Frank and Pohl) are larger values than those found for any gas but hydrogen. In the vacuum tube the dark space exhibits several distinct maxima showing long free paths (Aston).

The Zeeman effect is extremely simple and regular, the lines breaking up into normal triplets with dispersions $(d\lambda/\lambda^2)$ proportional to the fields up to 12,000 c.g.s. (Lohmann). Confirmatory observations with measurements of $e/m$ give values of this for $D_3$ $(\lambda = 5876)$ of $11·3 \times 10^6$ across and $12·3 \times 10^6$ parallel to the field, somewhat higher values being found for two other strong lines, $\lambda = 6678$ in the red and $\lambda = 5016$ in the blue-green (Grey and Stewart).

Gaseous helium has a small negative magnetic susceptibility of 0·00175, less than argon (Tänzler), while its dielectric cohesion is the lowest known. All monatomic gases have low values, argon being 39 where hydrogen is 205, but helium is 18·3, so that 0·005 per cent. of the diatomic gas can be clearly detected (Bouty).

It would seem as if this property might be a certain and easily applied method of checking the freedom of helium from hydrogen. Other methods of testing its purity are determinations of density and spectrum analysis. The former is extremely accurate when great precautions are taken, but does not easily give an accuracy of more than 0·05 per cent.; however, with the spectroscope it seems that 0·008 per cent. or less of hydrogen can be seen (Onnes).

It is, however, in its character of the most perfect known gas that helium has the most obvious usefulness, and this in two directions. At all temperatures below 100° C. a constant-volume helium thermometer is the most convenient and accurate known because the corrections are very small and regular. Determinations of the mean pressure coefficient from 0°·0 C. to 100°·0 C. gave values of 0·00366241 and 0·00366270 for a normal thermometer (760 mm. at 0°·0 C., Travers and others). These values, when corrected and re-calculated to the international scale (1000 mm. at 0°·0 C.), appear as 0·0036616 and 0·0036613, the former of which agrees exactly with a direct determination at this pressure (Onnes). To obtain these corrections use has been made of isotherms observed at 0°·0 C., 20°·0 C., and 100° C., and the corrections of the helium thermometer to the absolute scale are deduced from isotherms at the values given. They are −0°·006 at −103°·57 C., +0°·002 at −182°·75 C., and +0°·01 at −216°·56 C., while in later measurements of the boiling point +0°·2 is assumed at −268°·6 C. = 4°·5 K., if absolute zero = −273°·10 C. (Onnes). The isotherms indicate that there is no minimum until about −253° C., so that the Boyle point, where $(d(pv)/dp)_t = 0$, appears to lie at about this temperature, and hence the Joule-Kelvin inversion temperature, for small pressure differences, will lie at about twice this, or 40° K. The isotherm for −258°·82 exhibits a distinct minimum at about 10 atmospheres, as can be seen by plotting the following values for $pv$ against $p$; $p=0$, $pv = 0·05222$; $p = 40·012$, $pv = 0·06150$; $p = 46·222$, $pv = 0·06559$; $p = 53·326$, $pv = 0·07063$; $p = 58·797$, $pv = 0·07531$.

The value of the critical temperature, which had been variously given from 8° K. (Dewar) to 2° K. (Olszewski), and about 1° K. (Onnes and Keesom), was settled by these isotherms as not greater than 5°·3 K., and later observations of the liquid fixed it as little above 5° K. with a correspondingly low critical pressure of 2·3 atmospheres (Onnes). Liquid helium boiling normally at 4°·5 K. is very mobile, with an extremely small apparent surface tension and a density of 0·15, and is only eleven times denser than the vapour above it (Onnes).

In mixtures of helium and hydrogen the gaseous helium sinks in the liquid hydrogen at about 40 atmospheres (Onnes), which opens up a wide field of theoretical and practical investigation. The value of $b$, in van der Waals's equation, was assumed to be 0·0005 with a negligible $a$ (Onnes and Keeson), and this is in agreement with the value of 0·000432 calculated from the isotherms at and above $-217°$ C. (Onnes). From the observations on the liquid, however, it would seem that the value of $b$ should be 0·0007 there, and that $a$ must have a positive value of 0·00005 (Onnes). Lastly, the lowest steady temperature known was obtained by boiling helium at a pressure of not more than 1 cm., at which the temperature could not have been much above 3°·0 K. The liquid was mobile and perfectly clear, and no trace of solid was visible, so that a still lower steady temperature is clearly attainable (Onnes). FRANCIS HYNDMAN.

## THE INTERNATIONAL CONGRESS ON ROADS.

THE first International Road Congress was held in Paris during the week which ended on Saturday last, October 17. On the whole the congress may be pronounced a success, chiefly on account of the large number of interested visitors present, and from the fact that on certain points there was a strong consensus of opinion that roads can now be constructed to stand modern automobile traffic at slight additional cost, and that the two nuisances dust in summer and mud in winter can be greatly minimised in their extent.

The congress, though not wholly official, received the support of the French Government. The letters of invitation and explanatory circulars were sent out from the general secretary of the Ministère de Travaux publics; consequently the invitations were not confined to delegates sent by the Governments of the various countries represented, but were sent to representative public bodies, road authorities, automobile clubs, and to engineers and other members of the public who are likely to have knowledge and be interested in the great question of road communications.

The attendance at the meetings was generally very good; the rooms were crowded. As is usual, the hospitality shown by the French in the way of *fêtes* and excursions made the week very enjoyable to the French provincial visitors as well as to the foreign visitors. The first reception was at the Sorbonne, afterwards a grand evening reception at the Hôtel des Invalides, a gala performance at the Comédie Française, and a final sitting at the Sorbonne on Saturday morning announcing the results obtained.

The general procedure was as follows. Early in the year requests were sent to all the interested countries that contributions should be submitted in the form of short papers, which would be printed and circulated previous to the congress, the substance of which would be collected by a reporter of each of the groups, and on which discussions would take place. The subjects on which these memoirs were invited were the following:—General reports on the construction and maintenance of existing roads, special reports on the cost of road-bed and methods of construction of roads; special reports on maintenance questions—on this group of construction and maintenance of roads thirty-two papers were received, of which seven were by English contributors.

The second group of questions related to that part of road construction and maintenance which was rightly named at the congress "the present struggle against the wear and the dust." These included methods of cleaning and washing, and questions were specially put asking for experience in the use of tar or similar insoluble binding materials. Twenty-two papers were received in this group, five of them by English authors. Another group was on the roads of the future. On this question fifteen papers were received, none of them by English authors.

The remaining questions were those relating to traffic, damage caused to the roads by speed or by the weight of the vehicles, by pneumatic tyres, anti-skidding devices and similar matters. To this question sixteen papers were specially addressed, half of them by Englishmen. Then came seven papers, all by Frenchmen, on road signalling and milestones; and finally six papers on public vehicles used on the roadway, including tramway services. Five of these were by Frenchmen and one by a Spanish engineer.

Altogether ninety-eight papers were contributed, printed and circulated previous to the congress to all the subscribing members. This part of the work was splendidly done. The papers were sent in in their original language; in many cases they were completely translated; in some cases summaries were made in more than one language. It will be seen that about one-fifth of the whole of the papers came from England.

The discussions were divided into two sections, first those chiefly relating to road construction, and second those relating to the use of the roads and the vehicles running on them. They were held in the old tennis court at the corner of the Tuileries Gardens next to the Place de la Concorde, and on the plateau immediately surrounding this building were grouped a large number of modern appliances used on the roads, such as road rollers, road repairing machines, machinery for brushing and watering by horse-power and by automobile power, and, lastly, a long array of machines for distributing tar or other bituminous compounds on the road to render it waterproof and dustless. Inside the building a number of smaller exhibits were shown of various road materials and specimens cut out of existing roads, the latter being chiefly found on a collective English exhibit.

As stated at the commencement of this article, the success of the congress laid chiefly in the interest which it excited, and in the fact that for the first time a large number of road engineers and of those interested in the use of roads were brought together in a very pleasant manner, and, as is usual at these meetings, a great many useful friendships were formed which will undoubtedly lead to the better circulation of new ideas on road construction.

The number of English professional visitors was very large. Among the English visitors were found chairmen of the county councils, many of the most prominent county engineers, with a large sprinkling of municipal men and of surveyors of the various rural districts. As might be expected, a very considerable number of these gentlemen were not sufficiently familiar with French to follow the debates, which for the most part were conducted in French.

At an early stage it became evident that the knowledge possessed by some of the English visitors was very valuable to the congress, but that there was a great risk of their experience being lost, so that it was decided to hold supplementary meetings of the English-speaking, *i.e.* the English and American, visitors, previous to the regular meetings, and this course, although at first sight it might have seemed as if the English-speaking races wished to be exclusive, turned out to be of use. The results of the discussions by the English-speaking sections were delegated to one or two speakers, who afterwards communicated them during the main debates. In this way some useful resolutions were carried which cannot now be given, as they were not printed or agreed to in detail when the writer left Paris immediately after the final sitting on Saturday; but, speaking generally, it may be said that a great many of these resolutions are of but small importance to us in England, as they relate to such well understood and generally agreed to subjects as the necessity of providing substantial concrete foundations underneath paved roadways, a form of construction which has been generally adopted in England for the last quarter of a century, and to methods of drainage and similar matters equally understood by us.

On a matter, however, of common interest, that is, the substitution of tar or bituminous binding material in place of the water hitherto used to consolidate and hold together the road material, and which is conveniently dealt with under the French name "*Goudronnage*," the congress practically gave a unanimous answer. This was to the effect that if *goudronnage* be properly carried out; if the tar or similar material be chosen with reasonable care to avoid matter soluble in water, such as ammoniacal liquor remaining mixed in the tar so that it can be subsequently washed out by the rain or dried out in the form of crystals which might afterwards form an irritating dust; if the tar be put on in the correct quantity, and this quantity the smallest required to hold the individual stones of the road metal firmly in position, so that they never roll or move in relation to one another, and their upper surfaces are allowed to wear themselves bare of tar, it is not a difficult matter to obtain, at quite a moderate expense, a waterproof road which will not do any damage to vegetation, which will be practically dustless if it be swept at reasonable intervals from horse droppings or dust blown upon it from the adjoining land, and which need not be slippery, either to horse or to automobile traffic, whether the surface be wet or dry.

It appears certain also that by so dealing with the roadways their wear can be so greatly reduced that the annual cost of upkeep of roads so treated will be considerably less than the cost of the existing water-bound roads, of which so much of the material is lost by being blown away as dust in summer or washed away as mud in winter.

There can be no doubt that all engineers, English and Continental, are at one on this important question, and this in spite of the fact that many paragraphs, obviously inspired by those who wish to recommend other binding materials, were widely circulated in the journals during the progress of the congress. It had been roundly asserted that tar was a palliative, but that on the whole its defects were greater than its advantages. Those who were present at the congress know that this is an incorrect statement; that such damage as has occurred to trees and vegetation, or inconvenience to passengers, such as irritation of the eyes and throat, which followed on the early applications of tar to the French roads during the Grand Prix race, was due to well understood causes, that is to say, to the use of crude tar and its application to a road surface which had already broken up, both of which faults the congress unanimously condemned.

It may be here remarked that owing to the cautiousness, and hence the reticence, of some of the most important of our road authorities, the true position of England, which now possesses the greatest lengths of carefully waterproofed roads of any country in the world, was not put forward so much as might have been the case.

It was interesting to converse with American engineers, who, on account of the importance of road development in America, are studying this question very closely, and to hear from them how much more they could learn by visiting our English roads than anywhere in France, at any rate near the capital. French engineers, although they have practised *goudronnage* to a considerable extent, have not been careful enough in excluding the ammoniacal liquor, and in many cases have put on the tar irregularly and in far too great a quantity; wherever this is the case softening in hot weather and slipping in wet weather is likely to follow.

Before the congress of last week closed the question of the next congress was talked of, and it appears likely to be held in Brussels in about two years' time.

As regards that section of the congress relating to the influence of the vehicles themselves on the road, some of the papers were very valuable; but curiously enough the French, who above all other nations were the first to appreciate the great advantages of large wheel diameter, in their draft resolutions fixing the maximum weights to be carried per unit width of wheel left out the important factor of the influence of wheel diameter, though, luckily, owing to the influence of the English-speaking delegates, it is probable this factor will be reinstated in the form in which it exists in our own very well-considered regulations issued by the Local Government Board.

## SCIENCE AT THE UNIVERSITIES.

THE proceedings at the academic ceremonies held in Oxford on October 8 to celebrate the fiftieth anniversary of the opening of the University Museum, described in our issue of last week, and especially the address delivered by the Vice-Chancellor, Dr. Warren, President of Magdalen College, may well serve as an encouragement to the older men of science who have for many years been unwearying in their insistence that science should occupy a high place of honour among the branches of learning cultivated at the universities. The statement of progress at Oxford during the last fifty years, which the Vice-Chancellor and Dr. Vernon Harcourt presented, should act as an inspiration to the present distinguished staff of scientific teachers to whom the world is looking to develop in connection with their university a centre of scientific activity unsurpassed at any ancient or modern seat of learning.

How complete the change of attitude towards science has been at Oxford may be gathered from the description of the state of things immediately preceding the building of the museum which the Vice-Chancellor gave at the beginning of his address:—

> Science was not a stranger to Oxford before the first stone of the museum was laid, but her existence was somewhat precarious and her progress intermittent. The period just before the establishment of the museum was, like the night before the dawn, a somewhat dark age. It is, I believe, recognised in physiological science that the history of the embryo repeats the history of the race. It appeared to be so with science at that time. She was then in the condition of the cave dwellers among primitive men. At any rate, she lived underground. Her teachers, like those of the early Church, wandered about in "caves and dens of the earth." There was a cellar under the Ashmolean where science was taught. If I remember right, my old friend, whom I much wish we could have seen here to-day, Prof. Story-Maskelyne, was both taught, and instructed himself, in that underground chamber. There was another cellar, or series of cellars, in Balliol College, where my wife's father, Prof. Brodie, used to pursue chemistry; but it would not be fair to represent this as the whole history of science in Oxford even at that time. Dr. Daubeny at my own college, Magdalen, and Dean Buckland, as he afterwards was, at Christ Church, had already done pioneer work. To-day things are very different. Natural science has now, as you will see this afternoon, a palace with many chambers and apartments, well and, it may be said in some instances, beautifully equipped. That is not everything, and will not alone

secure success. Much of the very best work, as we all know, in science has been done in very inferior quarters and with very poor appliances.

Dr. Warren's personal acquaintance with the work of the museum, extending as it does over about two-thirds of the fifty years of its existence, his well-known strong interest in natural science, and his full appreciation of the paramount influence the scientific method exerts on every form of human activity, make his sketch of the work accomplished by the great men of science who have been associated with the museum especially valuable. He said :—

I have seen the museum, then, and its work, growing and advancing for something over thirty years. I can recall the individual characteristics and work of the eminent professors who have served it in its different departments during this period, the brilliant zoological series of Rolleston, Moseley, Lankester, and Weldon, and the brilliant geological series of Philips, Prestwich, and Green. I can remember the introduction of physiology and the epoch-making advent of Sir John Burdon-Sanderson. All along the line there has been continuous, steady, and healthy growth. I do not know how the number of students or the departments of the museum now would compare with that of the numbers when I was an undergraduate. I will take one simple test. I find that in 1872, the year I came to Oxford, the number of names in the natural science honours list is ten. The number of names last term in the corresponding list is seventy-four, seven times as many. When I was an undergraduate the Oxford Medical School was a shadow of a mighty name. The medical student was a *rara avis*. My impression is that there was one, or at the most two, a year at Balliol when I was there, and in the whole University I should doubt whether there were a dozen. In the strict sense there were hardly any. That is to say, there was scarcely a student studying medicine in any of its branches within the University. Now all that is changed. We have been singularly fortunate in our series of medical professors, Sir Henry Acland, Sir John Burdon-Sanderson, Dr. Osler. It would be difficult to show a more brilliant trio or a trio more suited to complement and supplement each other's labours. I have always held, and I think that experience has justified the belief, that a strong medical school would be for the advantage of pure science in Oxford. Out of practical schools, if properly administered, research work grows, just as again research gives ever new life to practical studies. I think the same is true of practical studies like forestry, which we have recently introduced; agriculture, a still later introduction; and engineering, which I am rejoiced to think is just going to commence its work here. It will be seen, then, that science has made an immense advance in Oxford.

We welcome this advance, and we look forward hopefully to the future in store for science in the University of Oxford. We acknowledge frankly and gratefully that the serious Oxford student realises fully the beneficial influence which the earnest pursuit of the methods of scientific inquiry in a university has upon other studies. We know that many Oxford professors and students of other subjects acknowledge that the adoption of the methods perfected by men of science to problems in their particular domains have led to unprecedented results. But it is still true that the average Oxford man leaves his Alma Mater profoundly ignorant of the scientific method, and with a scarcely veiled contempt for natural knowledge; and it is the ordinary university man, who remains undistinguished from the academic point of view, who eventually exerts a predominating influence in Parliament, and in county and municipal affairs.

In his address the Vice-Chancellor dealt with these facts, and his wise words foster the hope that steps will be taken to ensure that no man ignorant of the fundamental principles of science shall leave his university with any sort of academic diploma.

With all this activity in its own field, natural science does not really affect, as it should, the minds of the rank and file of our able young students here. It is not brought home to them; they do not appreciate or understand it. They either still retain some of that old prejudice and contempt which regarded science at schools as an *extra* or a *fad*, or else they are indifferent to it. Some few years ago I remember Prof. Lankester complaining that our statesmen and public men generally reared in our public schools and at the old universities were insensible of, indifferent to, the claims of science. I think that while he spoke strongly, as he often does, I think he also spoke as he not seldom does, even when he speaks strongly, with reason. This ought not to be the case. It is the scientific attitude and frame of mind, the scientific outlook on the world, as a part of general culture, which is, I think, what is wanted in education, and particularly in Oxford education, to-day. Oxford has many great intellectual traditions. Some of them are less strong than they were, but they are still potent. The old scholastic tradition, partly theological, partly philosophical, partly logical, is still potent with us. Our predominating school, even if it is now only *prima inter pares*, is the philosophical school of *Literae Humaniores*. It affects insensibly and indirectly even those who never read for it. It is an admirable tradition. So again is the more literary tradition of our classical scholarship. I hope that these traditions will always be maintained. I think they do to some extent affect the scientific student here. I should like to see them affect him more than they do, and I believe that I should carry many of the leading men of science with me in that desire. But what I should also like to see is the classical and the literary, the philosophical and the theological student, more affected by science. I should like to see science an element in our general education both in our schools and in the universities, and we are told, and I believe it is true, that if we wish to have it in the schools, we must insist on having it in the university. It is not so much that I think the small amount of actual knowledge which would be acquired by the individual student would be of great value, but I think it would conduce to the creation of this general atmosphere which I desire to see created.

Fortunately it is becoming recognised increasingly that the object to be aimed at in every sphere and stage of education is the inculcation of the scientific spirit, a patient training in the methods of science, which leads a person, whatever the problem with which he is confronted, courageously to look facts in the face, and after a broad survey of the conditions so far as available processes of inquiry make possible, humbly to endeavour to trace the causes of the effects which have been accurately and honestly recorded. Science has before now been taught, not only in schools, but in the universities themselves, in such a manner as to obscure rather than elucidate the attitude of the true man of science, but the Vice-Chancellor made it clear that this danger is fully appreciated at Oxford. As he remarked :—

The real lessons of science do not, I think, consist in knowledge of facts. . . . They consist in the recognition of the importance of truth, of absolute scrupulous accuracy in matters great or small; that nothing happens without a cause and without a consequence; that matter, however mutable it may be, is indestructible; that the same elements, or many of them, as are found in our earth may be found, for instance, in the sun, and probably pervade the universe; that energy in the same way is imperishable; the general scientific conception of force, of atoms, of gravitation, of resistance, of mass, of proportionate combination, and of the methods by which these truths were discovered and can be again demonstrated—these are the things which ought to be part of our common heritage and knowledge. I hope the next era will see, not the decay or the obliteration of the old traditions, but the addition of the new.

Thus to urge the claims of science as a valuable instrument of education of the kind necessary to train our legislators and administrators is in no way to belittle other kinds of knowledge. As the Rector of the Imperial College of Science and Technology said in a recent address, "the scientific man is, after all, first a man and then a man of science, nothing which leaves out of sight his obligation to rule his life in accordance with the highest standards of health, of religion, and of morals, can fairly be called a good education." The student of science, then, must not ignore that great body of humanistic learning which has always been held in high esteem at our ancient universities. There is every reason why the man of science should be so far as practicable also a man of letters. Humanists and men of science alike must remember, indeed they are remembering, that culture is something broader and higher than mediæval schoolmen imagined. The scholar steeped in classical lore, yet ignorant of nature and her laws, is, we are beginning to realise, an uneducated pedant. The specialist in science, sublimely unconscious of the beauties of literature, and knowing nothing of the ideas of ancient and modern poets and philosophers, is a hopeless Philistine. How much the man of science may learn from the man of letters, and how beneficial to scientific work the influence exerted by literature may be, the Vice-Chancellor showed convincingly towards the end of his address.

I think no less that the man of science has much to learn from the man of letters. It has certainly been the case that the best men, or many of the best men, of science have been men full of the love and spirit of letters, keenly sensible of the beauty and attraction both of poetry and of prose. It was the case, as we all know, with Huxley and with Tyndall. It was so with Helmholtz, whose intellectual relation to Goethe is a most interesting episode. The fact is not so generally recognised, but it was the case with Darwin. It may seem a paradox to say that Darwin was a "man of letters," but I am almost prepared to maintain it. Too much has been made of the well-known passage in his autobiography in which he describes how he lost, through atrophy, his love for poetry, and not enough has been made of the warmth and the keenness of that love in his earlier days. He was a boy at Shrewsbury in the ultra-classical days of that very classical school, and was rebuked by Dr. Butler, the headmaster, who called him a "*pococurante*" because he worked at chemistry. But he tells us that he was very fond at school of the "Odes" of Horace; and when we find him, in that delightful book, the "Voyage of the *Beagle*," quoting in a few consecutive pages lines from the "Third Aeneid" of Virgil and from Shelley in the most natural and spontaneous manner, I think we may assert that his love of letters was lively and deep, and likely to have a permanent effect on himself. I have always thought some of the pages of the "Origin of Species"—for instance, the concluding pages—among the most poetical pieces of prose in the English language, and I think the secret of that style is to be found partly in the hereditary gift of his family, and partly in the early cultivation which it received. Again, few things are more fascinating to the thinker than the history of early Greek philosophy—those wonderful guesses (afterwards passed on to the Romans) with which the Greek thinkers anticipated in an intuitive and in exact manner the theories and demonstrations of later science. I would have the student of Dalton familiar with the guesses of Democritus and their repetition by Lucretius, and familiar, if possible, with them in their place in history. I would have the student of Aristotle read Darwin, and the student of Darwin read, as Huxley did, his Aristotle.

Dr. Warren's address, as we have said, may well fill men of science with hope as to the future of our old universities. It has often been our duty to point out in these columns how the nation has suffered from the erroneous ideas which have prevailed at Oxford and elsewhere as to the educational needs of students destined to become members of Parliament or civil servants in high places. Again and again insistence has been laid on the fact that the kind of education suited to the conditions of the days of the Renaissance is not in harmony with present-day needs. The work of men of science in the last hundred years has revolutionised life, but it is only now that it is beginning to be understood that the education given by our universities and by our schools of every grade must be adapted to present and coming needs.

Recent years have witnessed in many of our great provincial cities the growth of new universities fired with modern ideals; universities which look to the union of the scientific spirit with all that is best in humanistic learning to produce men cognisant of modern needs and conditions, and fitted to grapple with the difficulties inseparable from the administration of a great empire. The increasing competition among the great nations for pride of place, whether in industrial warfare, in intellectual rivalry, or in the contest to secure the most satisfactory social conditions, will be decided eventually in favour of the people most able to apply the methods and conclusions of science. In other words, that nation will prevail which succeeds in best educating at its places of higher learning the men in whose hands its destinies must be placed.

These truths are understood at our new universities, and modern requirements are shaping their regulations, their courses of work, and their general administration. Dr. Warren's address leads us to believe that the aims and objects of the new universities are appreciated at Oxford, and that it is intelligently and completely known by the university authorities that no slackening of effort and no fainting by the way must be permitted in the work which has been so successfully begun of making Oxford a great scientific university.

## *FIBRES FOR PAPER-MAKING.*

THE Agricultural Department of the United States is investigating various fibrous waste materials with a view to their conversion into paper-makers' pulps or "half-stuffs." The *Times* of October 17 publishes a note giving some results of the experimental treatment of maize stalks, which are pronounced satisfactory.

The matter is of considerable importance. There exist a certain number of waste materials, such as megasse, cotton-seed hulls, flax and hemp straws of non-textile quality, which contain fibres useful for paper-making, and are available in concentrated areas in adequately large quantity to furnish "half-stuffs" in such volume as to be a serious factor in the determination of the world's supply, and therefore in controlling the ultimate cost of paper.

In considering these sources of supply, it is important to draw a sharp distinction between technical success and commercial success. All the above wastes have been, not once, but many times over, successfully worked up into papers of good quality. But for one reason or another the economic conditions for their industrial development have been lacking. A notable exception to this list of failures is the fibre of the cotton-seed hull. Within the last two years a definite industrial success has been recorded with this fibre, as the result of a treatment which is mainly mechanical. The fibre, purified from the adherent particles of shell, is now on the market under the name of "Virgo fibre."

Megasse, bamboo, and Para grass are being treated in Trinidad on practical lines; the half-stuffs and resulting papers are of remarkable quality, and the promises of industrial development are not unfavourable.

Flax and hemp straws constitute an attractive material, but all attempts to treat them on chemical lines have necessarily proved uneconomical. There is, however, every reason to expect that their successful exploitation, by the mechanical separation of their useful fibres in the districts where they are grown, is not far distant.

## NOTES.

The 200th anniversary of the birth of Albrecht von Haller—anatomist, physiologist, botanist, and poet—was celebrated on Friday of last week by the unveiling of a statue in his native city of Berne. The celebration was made the occasion of a public holiday, and was participated in by the State and municipal authorities, as well as by the professors and students of the University. It was also attended by delegates from numerous universities and learned societies, especially those with which Haller had been connected, the Royal Society being represented by Dr. Arthur Gamgee and the Royal Society of Edinburgh by Prof. Schäfer. An account of the proceedings will be given in a future number of Nature.

We are glad to notice that the King has appointed a Royal Commission to make an inventory of the ancient and historical monuments and constructions connected with or illustrative of the contemporary culture, civilisation, and conditions of life of the people in England from the earliest times to the year 1700, and to specify those which seem most worthy of preservation. The commission is constituted as follows:—Lord Burghclere (chairman); Earl of Plymouth, C.B.; Viscount Dillon; Lord Balcarres, M.P.; Sir H. H. Howorth, K.C.I.E., F.R.S.; Sir John F. F. Horner, K.C.V.O.; Mr. E. J. Horniman, M.P.; Dr. F. J. Haverfield, Camden professor of ancient history in the University of Oxford; Mr. L. Stokes, vice-president of the Royal Institute of British Architects; Mr. J. Fitzgerald, assistant secretary to H.M. Office of Works; and Mr J. G. N. Clift, hon. secretary to the British Archæological Association. The secretary of the commission is Mr. H. Duckworth, 35 Charles Street, Berkeley Square, W.

M. Henri Poincaré has succeeded the late M. Henri Becquerel as president of the French technical commission on radio-telegraphy, appointed by a decree of March 5, 1907.

M. Violle has been appointed president of the Bureau national scientifique et permanent des Poids et Mesures of Paris, in succession to the late M. Mascart.

Prof. T. L. Watson, professor of economic geology in the University of Virginia, has been elected director of the Virginia Geological Survey, and Dr. J. S. Grasty has been appointed assistant geologist.

We are requested to state that the annual "fungus foray" of the Essex Field Club will be held at Theydon Bois, Epping Forest, on Saturday, October 31. Mr. George Massee, of the Kew Herbarium, will act as principal referee, assisted by many botanists. Any botanist wishing to attend the meeting should write to Mr. W. Cole, hon. secretary, Buckhurst Hill, Essex, who will be glad to send programmes.

The Gunning prize, 1908, having the value of about 40*l*., will be awarded for an essay on "The Attitude of Science towards Miracles." The last day on which essays can be received for competition is March 31, 1909. Full particulars of the conditions can be obtained from the secretary of the Victoria Institute, 1 Adelphi Terrace House, London, W.C.

The death is announced of Prof. Adolf Wüllner, at Aix-la-Chapelle, at the age of sixty-three years. Wüllner was known for his work on the specific heat of liquids and gases, vapour tension, refractive indices, and the variability with temperature and pressure of absorption and emission spectra. He was the author of a standard "Lehrbuch der Experimentalphysik," which reached a fifth edition.

The death is announced of Mr. R. B. Smith in his seventieth year. Mr. Smith was formerly an assistant-master in Harrow School, and was a keen field naturalist. Among his published works is one entitled "Bird Life and Bird Lore," containing a number of interesting articles upon birds and their habits.

The fourth annual fossil-hunting expedition of Amherst College, Massachusetts, has just returned from a successful visit to the plains of Wyoming and Nebraska. It has collected between 3000 and 4000 Indian relics, a full skeleton of an extinct species of camel, parts of a skeleton of a huge rhinoceros, the jaws of a prehistoric dog, and other bones of the progenitors of the horse, dog, camel, cat, deer, beaver, peccary, &c. The expedition was led by Prof. Frederick B. Loomis.

Prof. G. Hellmann, president of the German Meteorological Society, asks us to announce that a prize of three thousand marks (150*l*.) is offered by the society for the best essay upon the meteorological results obtained in the exploration of the atmosphere by the international kite and balloon ascents. The prize is open to all nationalities, but the essays must be written in German, French, or English, and must be sent in before December 31, 1911. Further particulars can be obtained from Prof. G. Hellmann, Berlin W. 56, Schinkelplatz 6.

We learn from the *Times* that an International Fire Prevention Conference was opened on October 14 at the Conservatoire of Arts and Crafts, Paris. The conference has had under consideration the formation of a permanent French fire and accidents prevention committee, resembling the British Fire Prevention Committee, and the equipment of a testing station near Paris. Numerous technical matters relating to fire protection have been discussed, including the standardisation of the preventive measures of the European countries.

A short time ago we directed attention to an appeal for a fund, formed under the auspices of Mr. H. M. Taylor, F.R.S., of Trinity College, Cambridge, with the object of assisting in the publication of works of a scientific nature in embossed type for the use of the blind. The sum of about 525*l*. was subscribed, and the managers of the fund have agreed that the first three books in the publication of which they undertake to assist shall be "Sound and Music," by Mr. Sedley Taylor; "A Primer of Astronomy," by Sir Robert Ball, F.R.S.; and "An Introduction to Geology," by Dr. Marr, F.R.S.

The council of the Royal College of Surgeons at its quarterly meeting on October 16 adopted resolutions which will in future admit women to the examinations of the conjoint examining board in England, to the examination for the diploma in public health, to the examinations for the fellowship, and to the examinations for the license in dental surgery. This decision brings to an end an agitation which has been carried on for some twelve or thirteen years. The next steps are to arrange the necessary alterations of the bye-laws and to secure the approval by the Privy Council and the Home Secretary of the revised bye-laws.

THE report for the year of the English branch of the League for the Preservation of Swiss Scenery was presented at the general meeting held at the Royal Society of Arts on October 21. The report shows that there has been no slackening of the league's efforts in the direction of securing the preservation of the beauties of the Alps. The society has caused the circulation of a petition against the Matterhorn Railway, and has obtained nearly 70,000 signatures to the protest. Steps have been taken to formulate a scheme of protected areas. Opposition is to be offered to the proposed mode of constructing the railway through the Schöllenen Gorge by iron bridges, which would destroy the charm of the Teufelsbrücke. It is proposed, if possible, to prevent the sale abroad of the important collection at St. Moritz, illustrative of Swiss life and culture during four centuries, known as the Engadiner Museum. The league is keeping itself informed of the concessions applied for, and taking all possible steps to prevent needless and unprofitable interference with the grandeur of Swiss mountain scenery.

WE regret to see the announcement that Dr. Daniel C. Gilman, first president of the Johns Hopkins University, Baltimore, and afterwards head of the Carnegie Institute, Washington, died on October 14 at Norwich, Connecticut, at seventy-seven years of age. Educated first at Yale and then at Cambridge and Berlin, he was in 1856 appointed professor of geography in Yale University. He became president of the University of California in 1872. Five years later he went in the same capacity to the Johns Hopkins University. His work there, which lasted until 1901, secured him a place among the foremost American educators. In 1891 Dr. Gilman left Baltimore for Washington, where he spent three years organising the Carnegie Institute. In addition to the work of his various university appointments, Dr. Gilman was appointed by President Cleveland to act as commissioner in the Venezuela and British Guiana boundary dispute. He acted also as executive officer of the Geological Survey of Maryland. He was president of the American Oriental Society, and a prominent member of various learned societies and institutions. His many publications include a memoir of Dana the geologist, and "Science and Letters in Yale University."

WE regret to see the announcement of the death of Lieut.-Colonel Charles Thomas Bingham, late Bengal Staff Corps and Conservator of Forests, Burma, in his sixty-first year. During his long residence in India and Burma, he devoted much of his attention to natural history, and formed large collections, which he distributed liberally among museums and private naturalists, both in India and England, and many recent works on the natural history of India and Burma were largely based on these collections. Colonel Bingham interested himself greatly in all branches of natural history, and his earliest papers on the subject which we find noticed relate to birds, and were published in "Stray Feathers" from 1876–81. In some of these early papers he was assisted by the late Allan Hume. At a later period Colonel Bingham gave most of his time and attention to insects, especially Hymenoptera and Lepidoptera. From 1894 onwards a long series of important papers on Hymenoptera, chiefly those of the Indian region, appeared in various journals, and in 1897 and 1903 two volumes on the Hymenoptera of India, Ceylon, and Burma in the "Fauna of British India." These included the wasps, bees, ants, and cuckoo-wasps. On Colonel Bingham's final retirement from his official work he settled in London, devoting all his time and attention to his two favourite authors. In 1905 appeared the first volume on butterflies in the "Fauna of British India," and when, shortly afterwards, Dr. Blanford died, he was succeeded by Colonel Bingham as general editor of the series. In 1907 appeared the second volume on butterflies, and Colonel Bingham was engaged in the preparation of the third and concluding volume at the time of his death. He will be widely regretted by all who knew him, not only as a great naturalist, but also as a dear and valued friend.

THE inaugural meeting of the winter session of the London School of Tropical Medicine was held at the Royal Society of Medicine on October 14, under the presidency of Lord Crewe. The secretary reported that 849 students had passed through the school since its opening in 1899. Lord Crewe in his address alluded to the part taken by Mr. Chamberlain in the foundation of the school, to the interest of the Colonial Office in the schools of tropical medicine, and the important work these were doing for the State in fighting the scourge of disease in tropical countries. Sir Clifford Allbutt also addressed the meeting, dealing with variation in disease, the distribution of disease by traffic, and the importance in infection of the reaction of the host towards the parasite. Sir Patrick Manson, in moving a vote of thanks to the chairman and Sir Clifford Allbutt, said that the profession as a whole has had an enormous leavening by the students of tropical medicine. There is great difficulty in imparting even to the post-graduate mind anything like a knowledge of tropical medicine by a three months' course. Nothing is so gratifying as the support of the Government for the school. There is now a scheme on foot to attack one of the gravest medical problems affecting the inhabitants of the tropical world, namely, ankylostomiasis, a disease which, in consequence of the enormous number of people affected, is one of prime importance.

MANY naturalists will regret to learn that Mr. W. Saville-Kent died at Bournemouth, on October 11, from heart disease following an operation. Mr. Saville-Kent will perhaps be best remembered by his sumptuous work on the Great Barrier Reef of Australia, published in 1893. The remarkable photographs reproduced in that volume were unique in their beauty, and with the text they provided the scientific world with extensive and accurate information about coral reefs as represented by the largest existing coral structure. Mr. Saville-Kent also devoted great attention to oysters and oyster fisheries of Queensland, and in his presidential address to the Royal Society of Queensland in 1890 he urged the establishment of a well-appointed biological station on Thursday Island, which is the central depôt of the Torres Straits pearl and pearl-shell, and the *bêche-de-mer*, fisheries. In 1892 he exhibited at the Royal Society his photographs and colour sketches of coral reefs, coral animals, and the marine fauna generally of the Great Barrier district of Australia. He showed at the same time a pearl of fine quality and considerable size that he had caused the mother-of-pearl shell animal to produce by means of a delicately manipulated operation on the living animal. While engaged in 1893 as Commissioner of Fisheries to the Government of Western Australia, Mr. Saville-Kent sent to London a large collection of the stony corals peculiar to the

Australian coast-line. These specimens, added to the extensive series indigenous to the northern and eastern districts of Australia previously contributed by him to the Natural History Museum, constitute the most complete collection of Australian Madreporaria yet brought together. We understand that in recent years Mr. Saville-Kent's attention was given to the artificial cultivation of pearls in the large pearl-oyster.

October 17 was the 300th anniversary of the election of Francis Bacon as treasurer of Gray's Inn. The tercentenary celebration took the form of a luncheon at the inn, when the Benchers entertained a party of distinguished guests. The first night of term, November 2, is to be observed by the members of the inn as a Bacon anniversary, and later a marble statue of Bacon is to be erected in one of the open spaces of the inn. Mr. Duke, K.C., the treasurer, presided at the luncheon, and the American Ambassador was the principal guest. Among the party were Sir C. Allbutt, F.R.S., Sir Robert Ball, F.R.S., Sir J. Dewar, F.R.S., Prof. Frankland, F.R.S., Sir W. Huggins, K.C.B., O.M., F.R.S., Sir William Ramsay, K.C.B., F.R.S., Sir Henry Roscoe, F.R.S., Lord Strathcona, F.R.S., and other men of science. In proposing the toast to "The Immortal Memory of Francis Bacon," Mr. Duke dwelt at greatest length upon Bacon's connection with the legal profession, though he referred to his contributions to science and literature. The American Ambassador, in responding to the toast of "Our Guests," said:—"No man ever held a more extraordinary position than Bacon. It had been given to very few men in the world to change the whole intellectual current and tendency of their age and of succeeding ages. The whole effect of what had been called the Baconian philosophy was, according to his own statement of it, to look for fruit. It was essentially practical; and one of his acutest critics had said of him, his philosophy began in observation and it ended in words."

Particulars of the auroral display on September 29, as seen by Mr. J. H. Elgie from Roundhay Park, Leeds, are given by him in *T.P.'s Weekly* of October 15. "Shortly before nine o'clock a fan-shaped series of auroral streamers appeared under the western side of Boötes and the tail of the Bear. One magnificently defined shaft of light immersed Cor Caroli, which glittered vertically under the star at the tip of the Bear's tail. Cor Caroli was almost extinguished. For about an hour after that the northern sky remained quiescent, but that mystical glow continued. So light, indeed, was it, that at 9.25 I could distinctly see the time by my watch. The last of the display occurred at five minutes past ten, when a very beautiful streamer pierced Corona Borealis, and when it had died out the luminous suffusion died out with it." The display was referred to in a note which appeared in Nature of October 8 (p. 575) upon two magnetic storms observed at the National Physical Laboratory.

A complete change of weather has set in over the British Isles during the past week, and the temperature has fallen lower than at any time during the present autumn, the day and night readings towards the close of the period being in fair agreement with the average conditions for the time of year. For the first half of the present month the mean temperature in London was about 10° above the normal, and other parts of the country were similarly warm. Rain has now fallen in most parts of the United Kingdom, but the remainder of the month will have to be exceedingly wet if October is to have its normal rainfall. In London the aggregate measurement of rain for the forty-two days from September 4 is 0·51 inch, whereas the average for October is 2·73 inches. At Spurn Head the total rainfall this month to October 20 is 0·16 inch, whilst the average is 2·26 inches. At Nottingham the aggregate to October 20 is 0·28 inch, at Dover 0·31 inch, and at Jersey 0·38 inch. A region of high barometer readings has maintained a fairly fixed position over north-west Europe, and this has fended off the inroads of the moving disturbances from the Atlantic, compelling them to follow a more northerly track than usual. The type of weather, however, seems to be gradually assuming the conditions normal to autumn, and lower temperatures may now occur at any time.

The celebration of the tercentenary of the birth of Torricelli, to which we referred on July 9, ended on October 15. The following notes may be of interest to some of our readers; for amplification of them we may refer to meteorological text-books, and more particularly to Prof. Hellmann's article on the origin of meteorological observations and instruments in *Himmel und Erde* (vol. ii., parts iii. and iv.). Torricelli, the discoverer of the "Torricellian tube," afterwards called the barometer by the Hon. R. Boyle, received his first education at Faenza, and continued it at Rome. Some of his works on mechanics having attracted the attention of Galileo, the latter invited him to Florence, where he became the pupil of that great master. The constructors of a pump for the Duke of Florence having applied to Galileo for an explanation of the reason of the water not rising higher than about 32 feet, his cynical reply was that "nature abhors a vacuum"; but this reply apparently did not satisfy him. After Galileo's death Torricelli took up the subject, and assuming that the real cause of the water rising was the pressure of the air, he hit upon the idea of substituting mercury for water, and communicated his plan to his friend Viviani, who first carried out the experiment in 1643, and obtained similar results (allowing for difference of density). After this experiment Torricelli immediately declared the true cause of the phenomenon; in 1644 he also stated that the instrument would show certain variations in the weight of the air. The actual experiment of the decrease of pressure with altitude was made by Perrier on the Puy de Dôme in 1648, at the request of Pascal. Apparently Torricelli, who died in 1647, was too much occupied with his mathematical studies to take up the ultimate improvement of the instrument, which at that time had only an arbitrary scale.

In the October number of *British Birds* reference is made to the occurrence in Romney Marsh, at no very great distance from Lydd, of three American kill-deer plover in April last. All were shot. These bring the number of British-killed specimens to six; there is no reason to doubt that these were truly wild birds.

Fishes from Hawaii and Fiji form the subject of a paper by Dr. D. S. Jordan and Miss Dickerson published as No. 1625 of the Proceedings of the U.S. National Museum. A flying-fish is described as new, while *Scomber brachysomus* is made the type of the new genus Rastrelliger.

An interesting communication on the systematic position of the Palæozoic brachiopods of the genus Camarophorella is given by Mr. J. E. Hyde in the Proceedings of the Boston Society of Natural History (vol. xxxiv., No. 3). Hitherto the single known representative of the genus has been associated with Pentamerus, but the discovery of a second species enables the author to state that this is incorrect, its real affinities being with Meristella.

IN the annual report of the Sydney Technological Museum for 1906, a copy of which has just reached us, attention is specially directed to the building stones and ornamental marbles of New South Wales, which are stated to be fully equal to those of any other part of the world, although at present only a small portion of them is worked. A large series of specimens is exhibited in the museum. The report also refers to the exhibits sent by the Sydney Museum to the New Zealand International Exhibition of 1906.

ALMOST entirely new ground appears to have been covered, so far as the alcyonarian zoophytes are concerned, by the dredging of the U.S. Fisheries steamer *Albatross* in Hawaiian waters in 1902. According to an account by Prof. C. C. Nutting, forming No. 1624 of the Proceedings of the U.S. National Museum, out of sixty-eight species of these organisms collected in those waters during the cruise, no fewer than thirty-nine proved to be new. The order Gorgonacea, as might have been expected, was the most abundantly represented, comprising forty-seven species, while the Alcyonacea, which are chiefly Arctic, although abundant in Australian waters, comprised but five.

THE agricultural departments in the various sugar-producing countries are doing a great amount of work on the sugar-cane, and much confusion has arisen in the nomenclature of the many varieties now in cultivation, so that two stations may be working on one and the same variety under totally different names. By way of directing attention to this state of affairs Messrs. Deerr and Eckart recently issued a report from the experiment station of the Hawaiian Sugar Planters' Association giving lists of synonymous canes and discussing the origin of some of the better known varieties. There are numerous references to the literature of the subject, and the report promises to serve a very useful purpose.

IN Bulletin No. 66 of the Agricultural Experiment Station of New Mexico, attention is directed to a very important factor in connection with the fertility of the soil in countries where intense farming is not yet practised. It is well known that excessive cattle grazing is injurious for several reasons. The herbage deteriorates in value. The kinds of grass or other plants preferred by the animals get eaten before they have time to seed, and therefore die out, leaving only less valuable plants. The soil becomes so compacted by the treading of the animals, especially in the neighbourhood of the drinking places, that rain-water will not sink in, but flows over the surface in time of storm. Direction is given to the flow by the paths trodden by the animals, and from these small beginnings a great amount of land erosion may take place, with much consequent injury to the agricultural prospects of the country.

A PAPER of considerable interest dealing with the embryology of *Gnetum gnemon* is contributed by Prof. J. M. Coulter to the *Botanical Gazette* (July). The author fails to confirm the development, as described by Lotsy, of a compact tissue in the antipodal end of the embryo-sac, but observed a definite pavement tissue below the sac. The paper also contains details that were wanting of the early stages of the embryo. A long branched suspensor-like development of the fertilised ovum is formed, at one end of which a cell is cut off that gives rise to the embryo.

ARISING out of his extensive studies of African floras, in the course of which he has had occasion to note very numerous plant associations, Dr. Engler has sought to devise a general system of symbols for indicating plant formations in tropical and subtropical countries on maps or charts. The colour schemes present the most fundamental and important features. Generally, brown is used to signify saline habitats, green represents verdure and moisture, yellow the partially dry localities, red infers a high altitude, and black signs indicate very dry conditions. Dr. Engler's explanation, together with a chart of his proposed symbols, is published in his *Botanische Jahrbucher* (vol. xli., part v.).

IN the *Economic Journal* for September, under the title "Appreciations of Mathematical Theories," Prof. F. Y. Edgeworth discusses certain mathematical aspects of the much debated problem of "free trade" in a criticism of previous papers and reviews by Mr. Bickerdyke.

UNDER the auspices of the faculty of science of the University of Rome, a movement was set on foot to commemorate the contributions to physical science of Prof. Alfonso Sella, who died on November 25 of last year. A marble bust of Prof. Sella, by M. Ezekiel, was unveiled on June 9 of this year in the presence of a large number of subscribers and representatives of different universities, and a small memorial pamphlet has been published (Rome: G. Bertero and Co.) containing an account of the proceedings and a list of Sella's works.

IN issuing a supplementary list of drawing cases, &c., Mr. W. H. Harling, Finsbury Pavement, London, E.C., has taken the opportunity to send out a pamphlet dealing with slide rules. The brochure, in addition to giving prices and illustrations of instruments, explains the theory and use of the slide rule, and should prove of service to purchasers of this useful aid to calculation.

WE have received a very complete catalogue of bacteriological apparatus, surgical appliances, and hospital sundries from Messrs. Townson and Mercer. Many of the illustrations of the more complicated pieces of apparatus are accompanied by full descriptions and practical hints for using the instruments. In fact, some pages, like those concerned with biological incubators, read like parts of a laboratory manual. The catalogue, which is well produced, is arranged in such a manner that reference to it is easy and expeditious.

MESSRS. WRATTEN AND WAINWRIGHT, LTD., of Croydon, have issued a descriptive list of photographic dry plates, filters, and safelight screens they are prepared to supply. The catalogue directs special attention to the new X-ray plate, and in describing the many kinds of plates manufactured by the firm gives many useful, practical hints to enable photographers to secure the best results. Among other photographic requisites dealt with in the list may be mentioned screens, both orthochromatic and contrast; a series of safelights to give the greatest possible intensity of light with reasonable safety; and dark-room lamps.

A NEW list of meteorological instruments has been published by Messrs. C. F. Casella and Co., Rochester Row, S.W. Among new instruments described in the catalogue are some interesting forms of rain gauges. The "insulated Snowdon rain gauge" is of simple construction, and in it provision is made to protect the collected rain from freezing in winter and evaporation in summer. The "totalising rain gauge" is of the self-registering kind, and the principle underlying its construction is that of the tilting bucket, and it is claimed that a great advance has been made in the registering mechanism. The catalogue also includes a description of "Mountain's recording rain gauge," and particulars of balloons, kites, and accessories for the investigation of the upper atmosphere.

## OUR ASTRONOMICAL COLUMN.

COMET MOREHOUSE, 1908*c*.—A new ephemeris for comet 1908*c*, computed from the following elements and covering the period October 8 to December 7, is published by Herr Ebell in No. 4276 of the *Astronomische Nachrichten* (p. 61, October 9); these elements were calculated by Prof. Kobold, and appeared in No. 4275 of the same journal:—

$$T = 1908 \text{ December } 25\cdot8116 \text{ (M.T. Berlin).}$$
$$\left.\begin{aligned}\omega &= 171^\circ\ 39'\ 41''\cdot7\\ \Omega &= 103^\circ\ 11'\ 56''\cdot7\\ i &= 140^\circ\ 11'\ \ 7''\cdot4\end{aligned}\right\}\ 1908\cdot0$$
$$\log q = 9\cdot975278$$

According to the new ephemeris, the comet will attain its greatest brightness on October 24, and will then be about 5·6 times as bright as when discovered.

From notes in the *Gazette astronomique* (No. 10, p. 78) we learn that the comet was seen with the naked eye by several observers, at Antwerp, on September 20, the estimated magnitude of the head being 6·2, whilst the tail was 2° in length.

On October 18, at 8 p.m., the comet was seen as a naked-eye object at Chiswick, whilst with a 1½-inch operaglass, magnifying three times, it was quite a good object on October 14 and 18, the direction of the tail being made out quite easily. Photographs taken at the Solar Physics Observatory, South Kensington, with the 36-inch reflector and the 6-inch Dallmeyer camera, show that the tail is a complex structure of some five or six streamers.

COMET TEMPEL$_3$-SWIFT, 1908*d*.—Observations of the apparent position of comet 1908*d* were made at the Nice Observatory on September 29 and 30 and October 2 and 3 by M. Javelle, using the large equatorial of 760 mm. aperture, and M. Giacobini, using the equatorial *coudé* of 400 mm. aperture.

Comparing the observed apparent positions with the ephemeris positions (T=September 30·88) given by M. Maubant in No. 4269 of the *Astronomische Nachrichten*, it is seen that the corrections to the latter are about −14m. and +1° 24′. A further extract from the ephemeris is given hereunder:—

*Ephemeris 12h. M.T. Paris.*

| 1908 | α (h. m.) | δ (° ′) | log *r* | log Δ |
|---|---|---|---|---|
| Oct. 20 | 8 20·5 | +26 18·9 | 0·0719 | 9·8501 |
| 24 | 8 32·7 | +25 13·2 | 0·0762 | 9·8524 |
| 28 | 8 43·9 | +24 7·1 | 0·0812 | 9·8544 |
| Nov. 1 | 8 54·1 | +23 1·5 | 0·0867 | 9·8562 |

The positions determined at Nice are published in No. 4276 of the *Astronomische Nachrichten* (p. 61, October 9).

A BRIGHT METEOR.—Mr. Denning writes:—"I saw a conspicuous meteor on October 14 11h. 3m., =first magnitude, shooting exactly from β Andromedæ to between β and η Pegasi. Bright streak. The meteor was evidently an early Orionid, as the direction is from the usual radiant point at 91°+15°.

"I think this well-known October shower continues from the 9th to the 29th of the month, and I have never been able to trace the slightest change of position in the radiant, though I have watched the display very closely with the special purpose of ascertaining whether or not any displacement occurs."

VORTICES IN THE SUN'S ATMOSPHERE.—In No. 10 of the *Comptes rendus* M. Deslandres discusses the "long flocculi," or filaments, shown on spectroheliograms in the neighbourhood of sun-spots and disturbed regions. From a study of the spectroheliograms taken at Meudon, combining the results obtained with the spectroheliograph with those obtained with an instrument indicating the radial velocities of the particular solar vapours observed, he arrives at the conclusion that the filaments are in reality *tourbillons* with horizontal axes, parallel to the solar surface. Six drawings, from photographs, accompany the paper, and show the extent and direction of some of these filaments on various dates. In some cases the actual filaments are accompanied by "*alignements*," and are continuations or sections of them, whilst in others similar alignments are shown alone. In general, the latter are double and approximately parallel, including between the components an area a little less bright than the surrounding regions. These alignments generally intersect at faculic areas, and, if the latter be considered as cyclones having vertical axes, it is comprehensible that the former mark the lateral inrush of solar vapours to the cyclonic area. M. Deslandres considers that when the vertical movement is the more intense a spot is formed, and when the horizontal motion is the greater a dark filament, such as shown on Prof. Hale's recent photograph, results. He further urges the importance of a consistent research on these lines, and suggests that the results may prove valuable in the solution of problems relating to analogous movements in the terrestrial atmosphere.

THE ORBIT OF 42 COMÆ BERENICES (Σ 1728).—New elements of the orbit of the binary system 42 Comæ Berenices are published in No. 4276 of the *Astronomische Nachrichten* (p. 55) by Dr. Doberck. This system is of special interest, as the apparent motion is in a straight line, the plane of the orbit lying in the line of sight. Dr. Doberck finds that the period is 25·335 years, and that the eccentricity of the orbit is 0·4965, the apparent length of the semi-major axis being 0″·674.

THE RIO DE JANEIRO OBSERVATORY.—From the Minister of Industries we have received a copy of the "Annuario" published by the Rio de Janeiro Observatory for the current year. The volume contains a number of useful tables relating to astronomical and meteorological reductions, several calendars, tables for the conversion of measures from one system to another, and tables relating to cosmical physics, general physics, and chemistry.

## THE FIRST INTERNATIONAL CONGRESS ON REFRIGERATION.

IN an assembly which included ministers of railways and of agriculture, professors of physics, cold-storage engineers, fishery experts, fruit importers, and traffic managers, one naturally expected a very varied type of communication. A considerable portion of the available time was devoted to questions of such general importance as the settlement of units and the various legal matters in which cold storage, transport, and similar questions are getting involved. There were also a large number of purely scientific papers dealing with the production of cold, the determination of conductivity, and similar problems. Prof. H. K. Onnes gave, by special request, an account of his recent work on hydrogen and helium. He was followed by Prof. Mathias, who pointed out that, in the determination of the critical volume by his well-known straight-line law, substances did not follow, as a whole, the law of corresponding states. However, when divided up into groups, the correspondence was very perfect in the group. Prof. Onnes expressed the view that the divergencies must be ascribed to a difference of compressibility of the molecules themselves, or to a different distribution of potential round them. M. R. Pictet opposed strongly the view of ascribing an apparent volume to the molecules, and gave an interesting paper on the uses of low temperatures.

M. J. Becquerel communicated some of the results of the magneto-optic measurements he has made recently at Paris and Leyden. Particular interest was taken in the discovery of a phenomenon, resembling Zeeman's, in solutions and crystals. As a consequence, the section suggested that the nations should unite to construct a large electromagnet without iron to study such questions more effectively.

Oxygen is made from air in considerable quantities in Paris now by the Linde and the Claude processes. In principle there is not much difference, Linde employing pressures of about 60 kg. and Claude 20 kg. per sq. cm. There is a more economical distribution of pressure in the Claude method, a process which admits of the collection of nearly pure nitrogen. By an extension of the same method Claude is able to obtain neon and helium from the atmosphere, which is an interesting application of the principle of continuous fractional distillation for the purpose of obtaining what may be considered as traces of impurities.

It is arranged that an international bureau will be established for the purpose of regulating investigation and promoting uniformity in the methods of testing both machinery and products under the action of cold. The necessity of some such bureau was conclusively shown in the discussion on units. Certain people were desirous of introducing other than the C.G.S. units, and of stereotyping such units as the "frigorie" by a definition other than the present one of a negative calorie. It was felt, however, that these questions were too large for the section to discuss, and impossible for a full congress, so that they were left for the projected commission or bureau.

A question of prime importance in connection with the congress is that of a knowledge of the properties of the various non-conductors of heat used in practice. Up to the present most of the determinations published have been either on too costly materials or else on common materials in other conditions than those used in practice. The determination of coefficients of conductivity is one of no small difficulty, and an interesting review of various methods was given by Mr. W. D. A. Bost. A large series of careful measurements of the coefficients of conductivity of material in the form of thin plates has been made by M. A. Desvignes, using Lodge's modification of Forbes's method. Since the temperature coefficient for such bad conductors appears to be very small, the error introduced by applying such numbers to temperatures lower than the ordinary at which they were determined can only be one or two per cent. Much greater uncertainty is introduced owing to the different physical conditions of materials in practice, and also to the length of time before materials of considerable thickness really arrive at a steady state with regard to the flow of heat, and thus come into the condition in which the coefficients determined as above are applicable. From his own measurements Mr. G. Voorhees stated that as much as six days was necessary, even with thicknesses of the order of a decimetre, before the conductivity was proportional to the thickness. Again, nearly all non-conducting walls are composite, either being built up by bricks or slabs, or in several layers with an air space between, or both combined. The conductivity is thus much more complicated, and it is very questionable whether any satisfactory conclusions could be arrived at without more complete investigation on these various questions.

On the production of cold there were several interesting papers describing the various methods used and summing up their efficiency.

New elements were introduced by the description of a novel rotating machine using sulphur dioxide, invented by M. Singrün. In this machine the outside of the hermetically closed condenser is kept in continual rotation, the inner parts being hung and kept in place by their weight. Some small machines were in actual work, and certainly produced ice very rapidly and easily with an apparently small consumption of power; but no figures were given or indicators used to show exactly what was happening. There seems no doubt that the principle is new and most useful for small machines, as there is little lubrication and no taps to get out of order. In the case of the usual compressors, considerable economy can be gained by the use of the multiple-effect method. In this case the same cylinder is used for two or more pressures at the same stroke by a proper system of ports and connections. The result is that the usual indicator diagram, which has a very sharp peak, for such machines, is much broadened there, and the same plant has thus a considerably higher working value.

The sections devoting themselves to the application of refrigeration to food were concerned with the construction of cold stores of all descriptions, about which there was nothing of general interest. The effect of different degrees of cold and humidity is being studied very carefully by the United States Department of Agriculture, and some of the results were given by Miss E. Pennington. Experiments on chickens varied in length from a few hours to four years, both on chickens bought in the open market and with those the history of which was known. It was found that, as would be expected, the various bacilli were more numerous in the former class, and their numbers appeared to increase up to about a year, and then to decrease. Even at the end of four years there were some living. These long periods are not often employed in practice, about five months being the average at present. Very interesting photomicrographs were exhibited showing the gradual breaking down of the muscles, owing to the intrusion of foreign matter which increased with the time. In some cases the breakage was sharply at right angles to the muscle, which rendered the material very brittle. The material was also examined chemically, the changes which occurred being much greater in the open market class, and all tend to prove that the action is due to enzymes and not to bacteria. The loss of water, though great, was not of any dietetic importance, though it would affect the commercial value, but this might be controlled to a large extent.

One interesting point was the occurrence of mould at the end of very long terms. There seemed no reason to suppose that the mould had appeared after removal from the cold store, as the time was so short before examination. This is important in connection with the present position of the authorities in England and France with regard to moulds, those on rabbits and meat being assumed to render them unfit for food, while they are allowed on hams, &c.

Similar investigations on a less elaborate scale, with other food-stuffs and either frozen ($-9°$ C. to $-12°$ C.) or chilled ($-1°$ to $-2°$ C.), were given by other investigators. The results point to the necessity of finding the most suitable temperature for each material and of care in thawing, and also of using pure water for this proceeding. Under modern conditions and for reasonable times, there seems to be no appreciable decrease in the nutritive effects of food materials due to refrigeration; in fact, many harmful parasites are less likely to be present in frozen than in unfrozen meat and other foods.

In the production of flowers for market it is of great advantage to be able to have them as early as possible. It appears that in many cases the time of flowering can be advanced nearly two months by checking the foliage at a critical time. The investigations are only in their infancy, but promise very important results.

The use of dry air is of importance in many industries at the present time, and the employment of considerable cold appears to be the most convenient and economical means of obtaining it. This is markedly the case in the production of pig-iron in the blast-furnace, where the usual amount of humidity in the air leads to a considerable loss. It is said that by reducing the humidity to 6 grains per cubic foot, an increase of output of 20·4 per cent. and a saving of fuel of 13·4 per cent. has been obtained.

In the section devoted to legislation it became clear how extremely important it now is to have united effort in refrigeration matters, and its great importance to the British Empire was emphasised. In view of this importance it is remarkable, and entirely characteristic, that the British Government, in marked distinction to other countries, paid no attention to the congress.

In addition to the sectional meetings, congress lectures were given by Profs. von Linde and d'Arsonval. The former enlarged on the use of cold in dwelling houses, and took as his text the saying that the use of cold would advance civilisation in the tropics in a manner similar to that in which the temperate regions had been advanced by the employment of means of heating. Prof. d'Arsonval lectured on the science and industry of cold, reviewing our present position, and in this way closed a successful congress, in which nearly 4000 people, drawn from the whole world, took part.

It was decided to hold the next congress at Vienna in 1910, after which they will be triennial.

## *LOCAL ASSOCIATIONS FOR PROMOTING EUGENICS.*[1]

I PROPOSE to take the present opportunity of submitting some views of my own relating to that large province of eugenics which is concerned with favouring the families of those who are exceptionally fit for citizenship. Consequently, little or nothing will be said relating to what has been well termed by Dr. Saleeby "negative" eugenics, namely, with hindering the

[1] Address to a meeting of the Eugenics Education Society at the Grafton Galleries, on October 14, by Francis Galton, F.R.S.

marriages and the production of offspring by the exceptionally unfit. The latter is unquestionably the more pressing subject of the two, but it will soon be forced on the attention of the legislature by the recent report of the Royal Commission on the Feeble-minded. We may be content to await for awhile the discussions to which it will give rise, and which I am sure the members of this society will follow with keen interest, and with readiness to intervene when what may be advanced seems likely to result in actions of an anti-eugenic character.

The remarks I am about to make were suggested by hearing of a desire to further eugenics by means of local associations more or less affiliated to our own, combined with much doubt as to the most appropriate methods of establishing and conducting them. It is upon this very important branch of our wide subject that I propose to offer a few remarks.

It is difficult, while explaining what I have in view, to steer a course that shall keep clear of the mud flats of platitude on the one hand, and not come to grief against the rocks of over-precision on the other. There is no clear issue out of mere platitudes, while there is great danger in entering into details. A good scheme may be entirely compromised merely on account of public opinion not being ripe to receive it in the proposed form, or through a discovered flaw in some non-essential part of it. Experience shows that the safest course in a new undertaking is to proceed warily and tentatively towards the desired end, rather than freely and rashly along a predetermined route, however carefully it may have been elaborated on paper.

Again, whatever scheme of action is proposed for adoption must be neither Utopian nor extravagant, but accordant throughout with British sentiment and practice.

The successful establishment of any general system of constructive eugenics will, in my view (which I put forward with diffidence), depend largely upon the efforts of local associations acting in close harmony with a central society, like our own. A prominent part of its business will then consist in affording opportunities for the interchange of ideas and for the registration and comparison of results. Such a central society would tend to bring about a general uniformity of administration the value of which is so obvious that I do not stop to insist on it.

Assuming, as I do, that the powers at the command of the local associations will be almost purely social, let us consider how those associations might be formed and conducted so as to become exceedingly influential.

It is necessary to be somewhat precise at the outset, so I will begin with the by no means improbable supposition that in a given district a few individuals, some of them of local importance, are keenly desirous of starting a local association or society, and are prepared to take trouble to that end. How should they set to work?

Their initial step would seem to be to form themselves into a provisional executive committee, and to nominate a president, council, and other officers of the new society. This done, the society in question, though it would have no legal corporate existence, may be taken as formed.

The committee would next provide, with the aid of the central society, for a few sane and sensible lectures to be given on eugenics, including the A B C of heredity, at some convenient spot, and they would exert themselves to arouse a wide interest in the subject by making it known in the district. They would seek the cooperation of the local medical men, clergy, and lawyers, of the sanitary authorities, and of all officials whose administrative duties bring them into contact with various classes of society, and they would endeavour to collect round this nucleus that portion of the local community which was likely to be brought into sympathy with the eugenic cause. Every political organisation, every philanthropic agency, proceeds on some such lines as I have just sketched out.

The committee might next issue, on the part of the president and council of the new society, a series of invitations to guests at their social gatherings, where differences of rank should be studiously ignored. The judicious management of these gatherings would, of course, require considerable tact, but there are abundant precedents for them, among which I need only mention the meetings of the Primrose League at one end of the scale, and those held in Toynbee Hall at the other end. Given a not inclement day, an hour suitable to the occasion, a park or large garden to meet in, these informal yet select reunions might be made exceedingly pleasant, and very helpful to the eugenic cause.

The inquiries made by the committee when they were considering the names of strangers to whom invitations ought to be sent, would put them in possession of a large fund of information concerning the qualities of many notable individuals in their district, and their family histories. These family histories should be utilised for eugenic studies, and it should be the duty of the local council to cause them to be tabulated in an orderly way, and to communicate the more significant of them to the central society.

The chief of the notable qualities, to which I refer in the preceding paragraph, is the possession of what I will briefly call by the general term of "Worth." By this I mean the civic worthiness, or the value to the State, of a person, as it would probably be assessed by experts, or, say, by such of his fellow-workers as have earned the respect of the community in the midst of which they live. Thus the worth of soldiers would be such as it would be rated by respected soldiers, students by students, business men by business men, artists by artists, and so on. The State is a vastly complex organism, and the hope of obtaining a proportional representation of its best parts should be an avowed object of issuing invitations to these gatherings.

Speaking only for myself, if I had to classify persons according to worth, I should consider each of them under the three heads of physique, ability, and character, subject to the provision that inferiority in any one of the three should outweigh superiority in the other two. I rank physique first, because it is not only very valuable in itself and allied to many other good qualities, but has the additional merit of being easily rated. Ability I should place second on similar grounds, and character third, though in real importance it stands first of all. It is very difficult to rate character justly; the tenure of a position of trust is only a partial test of it, though a good one so far as it goes. Again, I wish to say emphatically that in what I have thrown out I have no desire to impose my own judgment on others, especially as I feel persuaded that almost any intelligent committee would so distribute their invitations to strangers as to include most, though perhaps not all, of the notable persons in the district.

By the continued action of local associations as described thus far, a very large amount of good work in eugenics would be incidentally done. Family histories would become familiar topics, the existence of good stocks would be discovered, and many persons of "worth" would be appreciated and made acquainted with each other who were formerly known only to a very restricted circle. It is probable that these persons, in their struggle to obtain appointments, would often receive valuable help from local sympathisers with eugenic principles. If local societies did no more than this for many years to come, they would have fully justified their existence by their valuable services.

A danger to which these societies will be liable arises from the inadequate knowledge joined to great zeal of some of the most active among their probable members. It may be said, without mincing words, with regard to much that has already been published, that the subject of eugenics is particularly attractive to "cranks." The councils of local societies will therefore be obliged to exercise great caution before accepting the memoirs offered to them, and much discretion in keeping discussions within the bounds of sobriety and common sense. The basis of eugenics is already firmly established, namely, that the offspring of "worthy" parents are, *on the whole*, more highly gifted by nature with faculties that conduce to "worthiness" than the offspring of less "worthy" parents. On the other hand, forecasts in respect to particular cases may be quite wrong. They have to be based on imperfect data. It cannot be too emphatically repeated that a great deal of careful statistical work has yet to be accomplished before the science of eugenics can make large advances.

I hesitate to speculate farther. A tree will have been planted; let it grow. Perhaps those who may thereafter feel themselves or be considered by others to be the possessors of notable eugenic qualities—let us for brevity call them "Eugenes"—will form their own clubs and look after their own interests. It is impossible to foresee what the state of public opinion will then be. Many elements of strength are needed, many dangers have to be evaded or overcome, before associations of Eugenes could be formed that would be stable in themselves, useful as institutions, and approved of by the outside world.

The suggestion I made in the earlier part of this paper that the executive committee of local associations should cooperate, wherever practicable, with local administrative authorities, proceeded on the assumption that the inhabitants of the districts selected as the eugenic "field" had a public spirit of their own and a sense of common interest. This sense would be greatly strengthened by the enlargement of mutual acquaintanceship and the spread of the eugenic idea consequent on the tactful action of the committee. It ought not to be difficult to arouse in the inhabitants a just pride in their own civic worthiness, analogous to the pride which a soldier feels in the good reputation of his regiment or a lad in that of his school. By this means a strong local eugenic opinion might easily be formed. It would be silently assisted by local object-lessons, in which the benefits derived through following eugenic rules and the bad effects of disregarding them were plainly to be discerned.

The power of social opinion is apt to be underrated rather than overrated. Like the atmosphere which we breathe and in which we move, social opinion operates powerfully without our being conscious of its weight. Everyone knows that governments, manners, and beliefs which were thought to be right, decorous, and true at one period have been judged wrong, indecorous, and false at another; and that views which we have heard expressed by those in authority over us in our childhood and early manhood tend to become axiomatic and unchangeable in mature life.

In circumscribed communities especially, social approval and disapproval exert a potent force. Its presence is only too easily read by those who are the object of either, in the countenances, bearing, and manner of persons whom they daily meet and converse with. Is it, then, I ask, too much to expect that when a public opinion in favour of eugenics has once taken sure hold of such communities and has been accepted by them as a quasi-religion, the result will be manifested in sundry and very effective modes of action which are as yet untried, and many of them even unforeseen?

Speaking for myself only, I look forward to local eugenic action in numerous directions, of which I will now specify one. It is the accumulation of considerable funds to start young couples of "worthy" qualities in their married life, and to assist them and their families at critical times. The gifts to those who are the reverse of "worthy" are enormous in amount; it is stated that the charitable donations or bequests in the year 1907 amounted to 4,868,050*l*. I am not prepared to say how much of this was judiciously spent, or in what ways, but merely quote the figures to justify the inference that many of the thousands of persons who are willing to give freely at the prompting of a sentiment based upon compassion might be persuaded to give largely also in response to the more virile desire of promoting the natural gifts and the national efficiency of future generations.

## *ZOOLOGY AT THE BRITISH ASSOCIATION.*

### *The Rule of Priority in Zoological Nomenclature.*

MR. G. A. BOULENGER expressed disapproval of the extreme application of the rule of priority in zoological nomenclature on the ground that it had already produced much mischief under the pretence of arriving at ultimate uniformity. The worst feature of the abuse of this rule is not so much the bestowal of unknown names on well-known animals as the transfer of names from one to another, as in the case of Astacus, Torpedo, Holothuria, Simia, Cynocephalus, &c., so that the names which were uniformly used by Cuvier, Johannes Müller, Owen, Agassiz, Darwin, Huxley, and Gegenbaur would no longer convey any meaning; very often they would be misunderstood, and the very object for which Latin or Latinised names were introduced would be defeated. While considering uniformity in the future, it was surely important to have some consideration for the past; the speaker suggested that names with which all general zoologists are familiar should be protected from the revisers of nomenclature, and that it might be possible for committees to be appointed to determine, group by group, which names are thus to be respected, not necessarily on the ground of their earliest date or their correct application in the past, but as having been universally used over a long period in a definite sense. Mr. Boulenger's proposals were supported by several subsequent speakers, and the section agreed that a resolution, in the sense of and containing the manifesto published in NATURE, vol. lxxviii., p. 395, be communicated to the principal British zoological societies, to Section C, and to the British representative on the committee of nomenclature of the International Congress of Zoology.

### *The Determination of Sex.*

A discussion, jointly with Section K, on the determination of sex, was opened by Mr. L. Doncaster. After briefly reviewing some of the recent work on the nucleus in this connection, he proceeded to describe a series of breeding experiments with the moth *Abraxas grossulariata* and the rare variety *lacticolor*, and concluded that the explanation of the results which he had obtained must be as follows:—(1) the sex determinants behave as Mendelian characters, maleness and femaleness being allelomorphic with one another, and femaleness dominant; (2) all females are heterozygotes, carrying recessive maleness, and producing male-bearing and female-bearing eggs in equal numbers; all males are homozygous, carrying only maleness and producing only male-bearing spermatozoa; (3) the *grossulariata* character cannot be borne by a female-bearing gamete.

Mr. W. Heape insisted that external circumstances, such as nutrition and general metabolism, could alter the proportion of the sexes in the young born.

Miss N. M. Stevens described her work on the spermatogenesis of several insects, devoting particular attention to the heterotropic chromosomes, in regard to which she confirmed Wilson's conclusions.

Prof. Bateson described Miss Durham's experiments with the cinnamon canary. When a cinnamon male is paired with a green female, all the males are cinnamon and the females green, but when a cinnamon female is paired with a green male all the offspring, of both sexes, are green. He then proceeded to consider a similar but less simple case, investigated by himself and Mr. Punnett, namely, the silky fowl, in which two pairs of allelomorphic characters are concerned in addition to the sex determinants. Both these cases are explicable on similar lines to those suggested for Abraxas. He gave instances of sex-limited inheritance, such as colour-blindness and hæmophilia in man, in which the males are affected and can transmit, while unaffected males cannot, but unaffected females may do so, the explanation being that the disease is dominant in the male and recessive in the female.

Dr. Copeman mentioned experiments which seemed to suggest that chemical factors may be important in sex determination, and a subsequent speaker referred to some sixty cases of old hen pheasants assuming male plumage as supporting the view that here it is the female which is heterozygous in sex, the male being homozygous, as no case of a male bird assuming female plumage was met with.

### *Account of the Recent Expedition to Lake Qurun.*

Dr. W. A. Cunnington gave an account of the results of the investigation, by Mr. C. L. Boulenger and himself, of the Birket el Qurun in the Fayum province of Egypt. The lake, though still of considerable size—twenty-five miles long and five or six miles in maximum breadth—is much smaller than formerly; raised beaches are seen in many parts, and the water is shallow (nowhere more than 4 to 5 fathoms deep) and brackish. The lake was found to be well stocked with animal life, although the number of species is not large. The large quantities of Entomostraca—principally copepods and Cladocera—doubtless form the food supply of the fishes, which occur in astonishing abundance; fifteen species of fish were obtained, all of which are well-known Nile forms. The swampy pools on the margin of the lake yielded ostracods, hydrachnids, and spiders. The Mollusca obtained belong to eleven species—two only of which are lamellibranchs—all of which are Nilotic forms. *Paranais littoralis*, a small oligochæte, was the only aquatic worm obtained, no leeches or Turbellaria being seen. Cordylophora was found growing in great abundance in the lake, an interesting fact, as it has not previously been recorded from Africa. Of especial interest are the presence in the lake of (1) a gymnolæmatous polyzoon with a circular lophophore and eight tentacles, and (2) a medusa and the associated hydroid stage—*Moerisia lyonsi*—which appear to bear a resemblance to Sarsia. Mr. Boulenger added further details regarding Mœrisia, and discussed its importance in relation to the possible former history of the lake.

*Structure of* Dendrosoma radians.

Prof. S. J. Hickson and Mr. J. T. Wadsworth conclude that the bodies described by Kent as the "exogenously produced germs" of Dendrosoma are epizoic, or possibly parasitic, Acinetaria belonging to the genus Urnula. The only true reproductive bodies of Dendrosoma are the so-called internal buds or gemmulæ, first described and figured by Levick. The micronuclei of Dendrosoma are 4 $\mu$ in diameter when they have reached their full size; when in division the length of the spindle is 24 $\mu$, and the chromosomes are numerous and minute. No centrosomes were seen, nor has conjugation been observed.

*Haematozoa from Ceylon Reptiles.*

Miss Muriel Robertson described several Hæmatozoa from Ceylon reptiles. The multiplication of *Haemogregarina nicoriae* takes place in tortoises (Nicoria and Emyda), and the transmitting host is a species of Branchellion, in the alimentary canal of which the hæmogregarine becomes motile. *Trypanosoma vittatae* and *Haemogregarina vittatae* are found in *Emyda vittata*, and the transmitting host of both is a species of Glossiphonia. Other hæmogregarines, trypanosomes, and a Hæmocystidium were described from lizards (*e.g.* Hemidactylus). (Other papers on trypanosomes and Piroplasma were given before a joint meeting of Sections D and I; for an account of these see "Physiology at the British Association," NATURE, October 8, p. 593).

*Giant Nerve Cells and Fibres of Halla.*

Dr. J. H. Ashworth described the structure and histology of the giant nerve cells of the polychæte *Halla parthenopeia*. These cells, of which there are usually fifteen to eighteen in each worm, are distinguished by their large size (they may attain a diameter of 150 $\mu$) and thick sheath. Fine chromophilous granules are present in the protoplasm (except in a peripheral zone, from which they are almost or quite absent) in varying amount in different giant cells. They are found in greatly increased mass in a specialised perinuclear zone, the outer edge of which is bounded by the perinuclear network of neurofibrillæ, which is thus in a position which facilitates its rapid nutrition. In the general protoplasm of the cell there is a network of neurofibrillæ, generally wider meshed and more slender stranded than the perinuclear network. From the intracellular network slender, primitive fibrils pass towards the giant fibre, and several stouter fibrillæ—six to ten from small cells, twelve to thirty from large cells—each formed by the fusion of several primitive fibrils, pass into the giant fibre, forming a bundle which occupies from one- to three-fourths of the lumen of the fibre. The fibrillæ in the giant fibre are generally of the same thickness, but occasionally one, two, or three fibrils are thicker than the rest. The contents of the giant fibre are equivalent and have a similar structure to the axis cylinder of a medullated nerve fibre, except that in the former there is nothing comparable to the nodes of Ranvier of the latter.

*The Vascular System of Stylodrilus.*

Mr. R. Southern directed attention to certain features of the vascular system of a new species of Stylodrilus from the River Annalee, co. Cavan. This differs from all other species in the presence of simple contractile saccular appendages on the posterior portion of the dorsal vessel, a condition intermediate between that seen in normal lumbriculids and that in the aberrant genus Stylodrilus. The relations of the dorsal and ventral vessels to the intestinal blood sinus were also described, and shown to differ considerably from those usually met with in oligochætes.

*The Respiration of Land Isopods.*

Mr. E. E. Unwin pointed out that woodlice are derived from aquatic ancestors, and, having taken to terrestrial life, have adapted their respiration to their altered environment. The different kinds of woodlice are, according to the speaker's experiments, suited to different degrees of dryness; *e.g. Trichoniscus pusillus* soon dies unless kept very damp, while *Porcellio scaber* can live four or five days in a dry box. *Ligia oceanica, Trichoniscus pusillus, Oniscus asellus, Porcellio scaber,* and *Armadillium vulgare* are arranged in order according to their habitat, and the structure of their respiratory organs shows a corresponding gradation from simple gills to gills supplemented by air tubes ramifying through some of the abdominal exopodites.

*The Distribution of Irish Fresh-water Mites.*

Mr. J. N. Halbert contributed some notes on the distribution of Irish fresh-water mites (Hydrachnida), pointing out that they may be divided, like the fresh-water mites in general, into two great faunistic groups:—(1) a group containing those widely distributed species which inhabit standing and slowly flowing waters of a comparatively high temperature, and (2) a group embracing those forms which are found in waters of a constantly lower temperature, especially those of cold highland lakes and streams.

*Arctic and Antarctic Collembola.*

Prof. G. H. Carpenter pointed out the comparative richness of the collembolan fauna of the remote northern and southern lands. The Poduridæ and Isotominæ are believed to be nearest to the primitive stock of the order, while the Entomobryinæ, the Tomocerinæ, and the Symphypleona are more highly specialised. It is suggestive that in both Arctic and Antarctic faunas the primitive genera are well represented, while the specialised genera have very few species. Two Arctic isotomines are present in our own islands—*Agrenia bidenticulata*, found last year in Irish and Scottish mountain streams, and *Proisotoma besclsii*, which inhabits the Arctic regions of both the Old and New Worlds and the coast of Scotland. "Bipolarity" in the Collembola is shown by Wahlgren's record of the latter species from Tierra del Fuego; a closely allied form is present in the South Orkneys. Such distribution indicates a high antiquity (probably Mesozoic) for this form. Several genera are apparently confined to the southern regions; for instance, Cryptopygus is represented by identical or nearly allied species in Tierra del Fuego, Graham Land, South Shetland, South Orkneys, and South Georgia, while *Isotoma octo-oculata* is present in Graham Land, South Shetland, South Orkneys, and Kerguelen, and the Isotoma of South Victoria Land is closely allied to a Fuegian species. Such distributional facts suggest the considerable geological age of the springtails and a former wide extension of the Antarctic continent. The National Antarctic (*Discovery*) Expedition collected from moss at Granite Harbour, South Victoria Land, a remarkable springtail, referable to the Poduridæ, but showing some striking affinities to the Isotominæ, which is apparently the most southerly terrestrial animal yet known.

*Mimicry in Lepidoptera.*

Dr. F. A. Dixey pointed out that when Fritz Müller put forward, in 1879, his theory of common warning colours, or the assimilation of one distasteful form to another for the sake of mutual protection against insectivorous enemies, he recognised the probability, or even certainty, that the approach would not necessarily be one-sided, but might be convergent, each form in some respects advancing to meet the other. This suggestion, however, was never developed by Fritz Müller, for although he mentioned a few instances in support of his view, he did not attempt to trace the supposed mutually mimetic process in any detail. Dr. Dixey showed that there is much evidence that such reciprocal approach, or interchange of obvious characters—for which the term diaposematism has been proposed by Prof. Poulton—does actually occur, and he exhibited some cases of mimicry the peculiar features of which are difficult to explain on any other hypothesis.

Prof. E. B. Poulton exhibited and described specimens illustrating mimicry in the butterflies of North America, and then proceeded to give an account of some recent investigations upon the African swallowtail, *Papilio dardanus* (*merope*), as an example of mimicry.

Mr. J. C. Moulton exhibited four groups of South American butterflies to illustrate the Müllerian theory of mimicry. In the Venezuelan group the general warning pattern consists of a chestnut background relieved by transverse black bars and yellow apical markings on the forewings. In the other groups the pattern is modified in various ways according to the environment; for example, in the Trinidad group yellow takes the place of the chestnut background, while the group from Ega, on the Upper Amazon, presents a more mottled and richer brown appearance, and in the fourth group, from Ecuador and Peru, the bars and mottled markings have given place to a dark background relieved only by a broad, oblique chestnut band.

*The Development of Littorina.*

Mr. W. M. Tattersall briefly described the development of several species of Littorina. The eggs of *L. littorea*, each enclosed in a hat-shaped capsule, are laid freely on the shore, and not aggregated together in a gelatinous mass. The larva leaves the egg as a trochosphere, and passes through a veliger stage to the adult. *L. littorea* lives low down on the shore among Laminaria and *Fucus serratus*. *L. obtusata* lives in a higher region of the shore, in the zone of *Fucus vesiculosus*; its larva leaves the egg as a veliger. *L. rudis* and *L. neritoides*, both of which live near high-water mark, are viviparous. Thus within the limits of a single genus there are presented three stages in the evolution of land Mollusca from marine forms, showing specialisation in reproduction and gradual abbreviation and final suppression of larval stages, correlated with successive stages of specialisation of habitat.

*Gastrulation in Amphioxus.*

Prof. E. W. MacBride pointed out that two theories have been advanced as to the mode in which the germinal layers are formed in Amphioxus:—(1) that the invagination is a simple process, and that the whole of the invaginated layer is endoderm from which notochord and mesoderm take their origin by a process of folding (as held by Kowalevsky, Hatschek, Samassa, and MacBride); (2) that the invagination is a double process; on the ventral side of the blastopore the cells are true endoderm, while on the dorsal side they are ectoderm (as held by Cerfontaine), and that the ectodermic roof of the archenteron becomes used up in the formation of the notochord and mesoderm, which are cut out of the wall of the archenteron by the upgrowth of the true endoderm cells at the sides. Prof. MacBride's observations lead him to conclude that all the intucked cells are endoderm, that the mesoderm originates from a dorso-lateral fold of the endodermic wall, which becomes cut into anterior and posterior halves by the growth of a septum; both halves of the fold remain open into the gut. The front half becomes eventually closed off, and corresponds to the mandibular head-cavity of other vertebrate embryos and to the collar-cavity of Balanoglossus. The posterior division, corresponding to the lateral plate of mesoderm of other vertebrate embryos and to the trunk cavities of Balanoglossus, retains its connection with the gut for a longer time; from its front end the somites of the body are cut off. The head cavities arise still later as a single median invagination of the anterior gut wall, which, before it separates from the gut, begins to be divided into right and left halves. The speaker concluded that, with some slight modifications, the simple view of the development of Amphioxus held by Kowalevsky and Hatschek was to be maintained.

*The Early Development of Dasyurus.*

Prof. J. P. Hill gave an account of the early development of the native cat (of southern Australia)—*Dasyurus viverrinus*. The uterine ovum is of large size as compared with the ova of Eutheria, is enclosed in a shell membrane, and exhibits a marked polarity, its lower pole consisting of dense, finely granular cytoplasm in which the pronuclei are situated, and its upper pole of a delicate reticulum with fluid-filled meshes. Prior to cleavage this latter portion of the ovum is separated off and takes no further part in development. The fluid material in this non-formative portion of the ovum is to be regarded as the product of an abortive attempt at the formation of a solid yolk-mass. By its elimination the potentially yolk-laden telolecithal ovum becomes converted into a secondary homolecithal homoblastic one. The first three cleavage planes are meridional; the resulting eight blastomeres are of equal size, and form an equatorial ring. The ensuing divisions (fourth cleavage) are parallel to the equator and are unequal, each of the eight blastomeres becoming divided into an upper, smaller, and clearer cell with relatively little deutoplasm, and a lower, larger, and denser cell with well-marked deutoplasmic contents. A sixteen-celled stage is thus produced in which the cells are arranged in two superimposed rings, each of eight cells. The descendants of these two cell-rings gradually spread towards opposite poles in contact with the thickened shell membrane, and constitute the cellular wall of the blastocyst, which is unilaminar, and remains so until the vesicle attains a diameter of 4–5 mm. The upper cell-ring is regarded as furnishing the formative (embryonal) portion of the vesicle wall—the homologue of the embryonal knot of the eutherian blastocyst—from which are derived the embryonal ectoderm and the entire endoderm, while the lower ring gives rise to the extra-embryonal portion of the vesicle wall, the trophoblastic ectoderm. The markedly different mode of formation of the blastocyst in the Eutheria was regarded as correlated with the complete loss of the shell membrane in the course of their phylogeny.

*The Wild Ancestors of Domestic Horses.*

Prof. J. C. Ewart gave an account of the wild ancestors of domestic horses, dealing particularly with (1) *Equus sivalensis* of northern India, a long-limbed form with the face strongly bent downwards; (2) *E. prejvalskii*, the horse which still lives in a wild state in Mongolia; (3) *E. robustus*, the remains of which occur at the Palæolithic settlement of Solutré, north of Lyons; and (4) *E. gracilis*, of the Auvergne and other French Pleistocene deposits, which seems to have given rise to *E. caballus libycus* (Ridgeway) of north Africa and to the Celtic pony (*E. caballus celticus*) of north-western Europe. Dr. Scharff mentioned that the horse remains found in the Irish crannogs, bogs, and caves bore out Prof. Ewart's view that a wild horse formerly existed in Ireland, of which the present-day Connemara pony seems to be the direct descendant.

*Feeding Habits of British Birds.*

Mr. C. Gordon Hewitt advocated the institution of an inquiry into the feeding habits of British birds, and urged that, in order to obtain as accurate a conception as possible of the economic status of any species of bird, it was necessary to examine and record the contents of the crop and stomach of a large number of individuals killed, not only in different months of the year, but also in different localities. Such evidence would provide the only safe guide to the protection of wild birds.

Dr. C. J. Patten gave an account of the migratory movements of certain shore birds, especially the sanderling and turnstone, as observed on the Dublin coast, and showed skins illustrating the phases of plumage changes according to sex, age, and season.

Prof. W. A. Herdman gave some natural-history notes on the Ceylon pearl oyster. These dealt with (1) the kind of ground on which the oysters live and the objects to which they are attached; (2) the oyster-eating fishes and other enemies which affect the life of the oyster; and (3) the different types of oyster and the question of their constancy.

Dr. A. Smith Woodward gave a lecture on the evolution of fishes. Prof. R. J. Anderson gave details respecting (1) the epiphyses of long bones, chiefly in sauropsids, and (2) measurements of the maxilla in Mammalia. Prof. Alexander Fraser directed attention to some points connected with the alimentary canal of the higher mammals, and Dr. H. E. Roaf gave a summary of his experiments on the physiological action of the digestive enzymes of certain invertebrates, but these communications cannot be summarised in the space here available. J. H. ASHWORTH.

## ENGINEERING AT THE BRITISH ASSOCIATION.

THE president of the section of engineering, Mr. Dugald Clerk, is so well known for his researches on the gas engine, and has done so much to place the theory of gas-engine work upon a true scientific basis, that it was only to be expected that the work of Section G should be largely concerned with gas-engine practice and allied industries. The president in his address gave an instructive and valuable summary of the early history of the study of thermodynamics, and of the application of its principles to engine design.

After the presidential address on Thursday, September 3, only one paper was dealt with, that by Mr. G. Stoney, on recent developments in steam turbines. At the York meeting in 1906 Mr. Stoney read a paper on the same subject, and the present paper, which was a continuation of the former, showed conclusively how rapid the progress had been during the past two years. The author first dealt with the changes in the design of continuous-current dynamos to adapt them to the high speed of the turbine, and stated that now as much as 1500 kw. was put into a single armature. In turbo-blowers for blast-furnace work there had been a great advance; a blower to deliver 20,000 cubic feet of air per minute only weighed 25 tons, against 450 tons for the ordinary reciprocating engine of the same capacity. The use of the exhaust steam from non-condensing reciprocating steam engines in turbines, which took in their steam at atmospheric pressure and exhausted it into condensers, was then dealt with, and such refinements as mixed-pressure turbines, where a high-pressure turbine using boiler steam comes automatically into action when the low-pressure steam supply fails. Improvements in condensers to increase the available vacuum—such a very important matter in turbine economy—were then touched upon, and, finally, the wonderful advance in the application of the turbine to marine work was briefly discussed—in eight years the horse-power so utilised had increased from 25,000 to 1,750,000.

Friday, September 4, was entirely devoted to a joint discussion with Sections A and B of the first report presented by the committee of the section on gaseous explosions, which was appointed at the Leicester meeting in 1907. This report not only summarised in a convenient form for reference what was known up to the present time on the subject, but also described the experimental work which had been carried out by various members of the committee. While Boyle's law might be considered holding under all the conditions met with in gaseous explosions in the gas engine, it had long been realised that it was probable that the law $PV=kT$ did not hold at the high temperatures reached in such explosions. The experimental work on this question was divided in the report into three classes:—(*a*) constant-pressure experiments; (*b*) constant-volume experiments; and (*c*) experiments in which both volume and pressure were varied; those carried out by Mr. Dugald Clerk fell into this last class. The results obtained by the various experimenters were fully discussed in the report, and from data obtained from several of the best-known experiments curves were drawn showing the relation between the temperature in degrees centigrade and the energy in calories per gram molecule. As a result of its investigations the committee had prepared a table giving the energy at four different temperatures in calories per gram molecule of air, $CO_2$, $H_2O$, gas-engine mixture, and ideal gas, and curves were drawn for the gas-engine mixture and the ideal gas. In the form of an appendix to the report was a valuable note, by Prof. H. L. Callendar, on the deviation of actual gases from the ideal state, and on experimental errors in the determination of their specific heats. Prof. Callendar showed that there was a possible systematic error inseparable from experiments made by Regnault's methods, due to the fact that the correction required for the flow of heat by conduction from the heater to the calorimeter had to be based upon experiments made with no gas passing. A long and interesting discussion took place, the chief speakers being Dr. Harker, Prof. Harold Dixon, who has done such excellent work in the determination of the specific heats of gases at high temperatures, Prof. Dalby, Prof. Coker, who described the method by which he had determined the fluctuation of temperature on the inner surface of the cylinder wall of a gas engine, and Prof. Bernard Hopkinson, who stated that in his experimental work he had discovered that the gases at the moment of combustion were able to radiate a considerable quantity of heat. The discussion was closed by the president of Section G, who expressed the view that the experimental work which is now being carried out by Prof. Callendar and Prof. Dalby, which was referred to by the latter gentleman in the discussion, would be of very great importance. Prof. Callendar and Prof. Dalby in their experiments on the determination of temperatures inside gas-engine cylinders used an extremely fine platinum wire, and withdrew it from the cylinder during the time the temperature was at its maximum, and, as a result of their work, they believed they had obtained temperatures accurate to within 1° C.; if the temperature is known accurately at one point of the indicator card, it could certainly be calculated for other points.

On Monday, September 7, the first three papers were devoted to peat and producer gas. Captain Sankey read the first paper, on the utilisation of peat for the making of gas or charcoal. He stated that the subject was one of great importance to Ireland, and was of interest in view of the fact that a Bill had been passed by Parliament sanctioning works to produce gas from peat, and to use this gas for making electricity by means of gas engines and dynamos, and to distribute the power thus generated to works which would be established in the neighbourhood of the power station. The Bill had given power to utilise a portion of the bog of Allan, near Robertstown, on the Grand Canal, about twenty-five miles from Dublin. Earlier attempts to utilise peat had failed, because they were based on the use of dry peat, that is, peat containing 25 per cent. of water, and the cost of such drying and of converting the dry material into briquettes was too great to allow it to compete with coal, and, further, there was no recovery of by-products. The proposed scheme proceeded on different lines; the peat would only be partially dried, that is, to abnut 60 per cent., and it would then be used in producers for generating gas, and the by-products would be recovered. It was hoped that the profits on these would cover the cost of procuring and drying the peat. Great progress had been made in Germany in the utilisation of peat, and the author described several plants he had seen at work. The peat could be obtained by four different methods:—by hand labour entirely, by cutting by hand and then shovelling it into an elevator, or by digging it and spreading it for drying by a machine, or, finally, the peat could be dug by means of an ordinary grab, which was the method adopted at Schelecken, in Prussia. Probably the grab method would be the best for the proposed power scheme, and the drying might be carried out by means of Dornberg presses. The principal by-product in the manufacture of peat gas is sulphate of ammonia, and the proposed power station would probably be able to produce about 3000 tons per annum. Other important by-products are acetate of lime, methyl alcohol, and tar; an excellent waggon grease can be made from this tar. The author estimated that the monetary value of these additional by-products would be equal to that of the sulphate of ammonia, and he stated that a good charcoal could be made direct from peat and the by-products recovered, and that a satisfactory process had been in operation in Oldenberg for more than ten years.

The second paper, on producer gas, by Mr. Emerson Dowson, was noteworthy from the fact that the first paper on this subject by the author was read at the York meeting in 1881; the present paper contained a summary of the progress which had been made during the last quarter of a century. In concluding his paper, Mr. Dowson dealt briefly with the two types of producers now utilised for engine work. The suction plant cost less and occupied less ground space, but the gas made in it was not so strong as in the older form of pressure plant—in some cases this advantage of the latter is important. He stated that the fuel consumption per horse-power hour and the labour required were about the same in both types of plant, provided the steam required was raised by means of an independent boiler.

The third paper, by Mr. Robson, was entitled "The Production of Cheap Power by Suction Gas Plants." The author stated that the figures he was able to produce showed that the modern gas engine and suction producer could give power to small users and to large users more cheaply than could be obtained by any other process. In the form of a table he gave three typical examples, one, where the installation was 450 B.H.P., the total cost per B.H.P. hour, allowing for depreciation and interest on capital, worked out at 0·205*d*., and where the size of the installation was only 20 B.H.P. the cost was 0·745*d*. Up to the present suction producers had been made to work on a commercial scale only with non-bituminous fuels, and fortunately such fuels were easily obtainable in the industrial centres of this kingdom. The tar difficulty had been the chief trouble in making a successful suction producer work with bituminous fuels, as the apparatus required for the cleaning of the gas both increased the frictional resistance of the passage of the gas from the generator to the engine and destroyed the simplicity of the arrangement. The author discussed several methods by which this difficulty might, he considered, be overcome.

In the discussion on these papers, Mr. W. Crossley, the well-known gas-engine maker, gave some interesting figures his firm had obtained as the result of experiments they had been carrying out on the utilisation of peat with a peat containing 2·2 per cent. of N; they estimated that a profit of 5*l*. 12*s*. per ton would be obtained from the sulphate of ammonia, and with 1·6 per cent. of N (about the average figure for Irish peat) the profit would still be 4*l*. 1*s*. per ton of sulphate of ammonia produced; this practically meant that the power which would be generated would cost nothing, and could, therefore, be retailed at a cost which would ensure the establishment of industries requiring a large amount of power at a low cost.

The concluding paper for the day was by Mr. W. Rosenhain, on the study of breakages. The author, after emphasising the need of a careful study of every case of breakage, if engineers were to obtain information which would enable them to prevent the recurrence of such breakages, stated that the causes of failure might be classed into three different groups:—(1) those due to defects arising from the manufacture of the material of construction; (2) those arising from incorrect treatment of the material during the process of construction; and (3) those from defects arising during the life of the structure or machine. Mr. Rosenhain illustrated these three cases by examples selected from investigations which had been carried out at the National Physical Laboratory. The first case was that in which the inner tube of a large gun had failed by internal cracks, and the microscopic and mechanical tests showed that the failure was probably due to a defect in the original steel ingot, viz. to its contamination to an undue extent with enclosures of slag. The second case was a fractured locomotive crank pin; here the microscopic investigation pointed to the conclusion that a material of an originally satisfactory character had been spoiled by a too severe hardening process; this example was a direct testimony to the value of microscopic observations in giving a clue to the thermal history of a specimen of steel. The third case was a broken shaft, where the investigation showed that the coarse structure of the material in the central portion of the cross-section of the shaft, which was undoubtedly the cause of the fracture, had been present in the steel as supplied by the manufacturer, and could not have been produced as the result of vibration or working stresses. Mr. Rosenhain's paper was an extremely valuable one, and indicated the good work which is being and can be carried out in such an institution as the National Physical Laboratory.

A paper by Prof. E. Wilson, describing his further experiments on the electrical conductivity of light aluminium alloys as affected by exposure to London atmosphere, was taken as read.

The section opened its proceedings on Tuesday, September 8, with a paper by Mr. F. W. Lanchester on the laws of flight. The paper was illustrated by a number of interesting experiments with model aëroplanes. Mr. Lanchester has been working on the subject for a number of years, and has evolved mathematical expressions for the path which is followed by a ballasted aëroplane and for its stability; generally speaking, the path is undulating, and under certain conditions the aëroplane will describe complete loops in the air. The mathematical investigations into the stability of aëroplanes showed that the velocity of flight must be considerable when the machine was a large one, and therefore a large plane required more power per lb. of weight than a small one, thus limiting the weight of flying machines of the aëroplane type. Mr. Lanchester directed attention to the fact that there was not much to be gained from the study of the flight of birds, carried out in the haphazard fashion which had hitherto characterised such work; he pointed out, in particular, that it was only rarely that the observer had ever recorded the weight of the birds the flight of which he had been studying. In the course of the discussion Mr. Lanchester stated that, in his opinion, the engine problem would not be simplified in the case of large-sized aëroplanes, and he thought that the engines would require to be air-cooled; he had himself built a considerable number of such engines, which worked quite successfully. At the present time he was of opinion that the best results would be obtained with a machine weighing, with its driver, not more than half a ton.

The next paper was by Mr. F. A. Royce, on the causes of wear in motor vehicle machinery; the author dealt with his subject under three heads:—(*a*) design; (*b*) material and workmanship; (*c*) lubrication and attention. To illustrate his first point examples of defective designs in bearings were discussed and criticised, and in connection with lubrication the importance of devices for retaining the oil on parts subjected to friction, and of always maintaining a film of oil between the rubbing surfaces, was strongly emphasised.

The last paper of the day was one by Sir Howard Grubb, on clock-driving mechanisms for telescopes; for spectroscopic and photographic work with telescopes it was necessary that the clock-driving mechanism should not only drive the telescope at its normal rate, but also correct any errors of position which might occur and would accumulate. The problem—always a difficult one—had been solved most satisfactorily by the use of electrical control, and the author described the method adopted by him for the 24-inch equatorial at Oxford University; the mechanism is, briefly, epicyclic gearing, which is operated electrically, the necessary electrical contacts being controlled by a pendulum. In the discussion Dr. Rambaut, of Oxford University Observatory, stated that the delicacy of the adjustment obtained by this device was remarkable; the tube of the telescope was 22 feet 6 inches long, hence a second of arc was represented by a linear measurement of less than 1/100 millimetre, while in their photographic work they aspired to keep the position of the images true to 1/12,000 millimetre, and not only was the delicacy of the adjustment so perfect, but the simplicity was equally remarkable; it was quite unusual for any adjustments to be required.

Owing to the number of papers presented, the section sat again on the morning of Wednesday, September 9, when three papers were read. The first, by Mr. J. Brown, F.R.S., and Prof. Maurice Fitzgerald, described a series of experiments they had carried out on rotating discs. The discs were rubber—one solid, 12 inches in diameter, with its thickness tapering from $2\frac{1}{2}$ inches in the middle to $\frac{1}{2}$ inch at the edge, and the second 12 inches in diameter, $\frac{3}{8}$-inch thick at the edge, and 3 inches thick in the middle, where it was pierced with a $1\frac{1}{2}$-inch hole. In the first disc the thickness varied uniformly from the centre to the edge; in the second the cross-section of the disc formed a hyperbolic curve. The object of these experiments was to determine, by measurement of the strains set up when the discs were rotating, whether the formulæ usually employed in the calculation of stresses in the revolving discs of steam turbines were reasonably trustworthy. The discs were carried at the lower end of a vertical shaft, which was driven at a high speed by an electric motor; photographs were taken of the revolving disc, and strain measurements were thus possible. As a result of their experiments, the authors were of opinion that the ordinary formulæ did not give results which were approximate enough for ordinary use. Of course it is well known that these formulæ are only approximate, but it is doubtful whether the experiments of the authors are sufficiently conclusive to prove that the formulæ are as untrustworthy as was suggested in the paper.

The next paper was by Mr. Douglas Fox, on general urban and interurban transportation and rail-less electric traction. This paper contained, in the form of tables, an exhaustive analysis of the costs, working expenses, receipts, &c., of some seventy-one tramway installations in the United Kingdom. The examples selected by the author embraced towns having combined generating stations for traction and electric lighting, and towns which had separate generating stations for their tramways and their lighting. Details were also given of several installations of electric road traction on the Continent, where overhead wires were employed and there were no rails; one of the latest of these was at Mulhausen, in Alsace, where it had been decided to adopt rail-less electric cars in order to connect up the suburbs with the existing electric tramways in the city proper. Mr. Fox was of opinion that in many of the municipal tramways ordinary business principles had been neglected and that the public had been allowed to travel at the expense of the ratepayer, fares being too low to allow, after working expenses had been defrayed, of the setting aside of a reasonable sum for depreciation and renewal.

The section concluded its proceedings with a paper on the strength of solid cylindrical, round-ended columns, by Prof. W. E. Lilly. In previous papers by this author the importance of secondary flexure and its influence on the strength of columns had been demonstrated, and as a result of his researches he had suggested the revision of the formula at present in use for the design of columns. The modified formula which the author had suggested required certain constants, and the object of the experiments described in the present paper was the determination of the value of these constants. Experiments had been carried out on columns of cast tool steel, Bessemer steel, mild steel, wrought-iron, and cast-iron, and the results obtained were given by the author in the form of a table; the constants in this table were for use with the well-known Rankine Gordon formula.

## *AGRICULTURE AT THE BRITISH ASSOCIATION.*

THE Dublin meeting of the British Association was marked by the resuscitation of the subsection of agriculture, which, after a previous temporary existence as a dependent of botany and some fitful appearances as a branch of chemistry, now became associated with economics. As was appropriate in these circumstances, and with Sir Horace Plunkett as president, the work of the subsection was mainly concerned with the economic, or rather with the sociological, side of agriculture.

Thursday morning was occupied with the presidential address, in which, at the outset, Sir Horace said that he spoke neither as a man of science nor as a practical farmer, but as a man of affairs whose way of life had brought him into close touch with the conditions, human and material, which it will be the aim of the subsection to improve. His purpose was to establish the claim of agriculture to a new position in the domain of science, for reasons that are primarily neither scientific nor practical, but political. It does not appear to have been sufficiently considered how far the ethical and physical health of the modern city has been due to the constant influx of fresh blood from the country. At present the town makes an irresistible appeal to the spirit of enterprise, to the growing craving for excitement, to the desire to live where there is most life. But sooner or later, if the balance of trade in this human traffic be not adjusted, the raw material out of which urban society is made will be seriously deteriorated, and the national degeneracy will be properly charged to those who failed to foresee the evil and treat the cause. If the problem has not yet received the proper attention at the hands of the sciences, its urgency is growing in the public opinion and stirring the centres of government. The influence of the British Association upon national life must depend, not upon its highest achievements in the region of pure science, but upon the degree in which it establishes and maintains a mutually helpful relationship between science and productive effort. He did not suggest that agriculture had not shared in the benefits with which science, physical and social, had richly endowed the whole field of industrial effort, urban and rural. But there is surely a marked disparity between the attention given to urban and rural affairs by those engaged in the application of science to the advancement of mankind. A great gulf, no doubt, separates the agriculture of Vergil from that of Sir John Lawes, but how insignificant it is beside the ocean of knowledge which stretches between Archimedes and Lord Kelvin. In his work in Ireland he had been in the habit of employing a rough formula to indicate the three-fold character of the constructive work that is needed in rural life—*better farming*, *better business*, and *better living*. To each of these three divisions the sciences ought to be most helpful; the natural sciences to the first, economic science to the second and third, educational science to all three. Sir Horace then proceeded to emphasise in greater detail the necessary part played by research, by economic investigation, and by education in rural reconstruction. Lastly, he proceeded to plead for the more adequate recognition of agriculture by the association; he demanded that it should be accorded the dignity of a section instead of being left in its present unstable condition, without any organisation to secure the continuity of even a subsection from year to year. The association might thus help to "counteract tendencies through which preceding empires, after they had arrived at a stage very similar to that which we occupy to-day, hastened to their decline and fall. Be this as it may, it would hardly be an exaggeration to say that modern civilisation has joined the rural exodus. Let it be the high aim of the British Association, leading science and practice hand in hand, to call it back."

In the afternoon following the presidential address, Sir Oliver Lodge described some of the experiments, which are being made on a large scale near Worcester, on the effects of a high-tension electrical discharge over a growing crop. While carefully guarding himself from any speculation as to whether the seat of the action was in the soil or the plant, whether a stimulus action or an inflow of energy, there seemed to be a positive result which was quite outside the domain of experimental error. Mr. J. H. Priestley, who has been associated with the experiments, gave some further details, and explained the investigations he had in hand to elucidate the nature of the action of the electricity. Then followed a paper by Prof. J. R. Campbell, of the Irish Department of Agriculture, in which he lucidly explained the educational work of that department, where the following of a carefully considered policy has achieved much happier results than the wasteful English method of leaving each county council to go as it pleases. Education was also the text of the next paper, by Dr. Carroll Dunham, of Harvard, in which he compared the systems of agricultural education prevailing in the United States, according as their aim was to prepare the students for business as farmers or for teaching and research.

Two more purely scientific papers were also taken on the first day; Dr. G. H. Carpenter described some of his work upon the warble-fly and its attacks, and Mr. H. Hunter explained the results of the long and systematic trials of barley varieties that have been made in Ireland by the cooperation of Messrs. Guinness with the Department of Agriculture. These trials have established beyond any doubt the general superiority of "Archer" to other barleys, both from the farmers' and the brewers' standpoint, thus confirming the results of the very similar trials made in Denmark.

Friday was given over to papers and discussions on breeding and on the light which science is beginning to throw on the problems of the stock raiser. Mr. Bateson opened the proceedings by a luminous exposition of the Mendelian standpoint, with illustrations of how the work of the raiser of new varieties of plants or the improver of breeds of animals could reduce his work to something like certainty, and work by design instead of by chance. Mr. W. Heape, F.R.S., who followed, pleaded for the establishment of experimental farms devoted to the solution of breeding problems; attention is at present exclusively given to the raising of crops, forgetting the enormous importance of our live-stock business. To Ireland such experimental work would be specially valuable. Mr. Punnett then gave an account of some of the more special applications of the Mendelian principles to stock questions, and Prof. J. Wilson showed how the facts of colour inheritance in cattle led to certain conclusions concerning the original races of cattle which have gone to make up the breeds now prevailing in the British Islands.

On the Monday the section resumed its previous economic point of view, and gave itself up to a very animated discussion of the factors which make for the success of small holdings. Mrs. Wilkins (Miss Jebb) opened the proceedings with a paper in which she sketched the very various conditions under which success had been achieved in England, and the necessity of certain collateral developments, such as cooperation, if any considerable numbers of small holders have to support themselves upon the land. She maintained that the fact that small tradespeople and mechanics rather than agricultural labourers are at the present moment chiefly applying for small holdings is really a good omen for the success of the movement, since such men are, as a rule, better able to make an economic use of the land than men who would be forced to depend wholly upon their small farming.

Mr. Christopher Turnor insisted on the importance of guiding the small holder in his methods of work and cropping, even to the extent of establishing in each district one or two model holdings cultivated for demonstration purposes. Mr. F. Impey gave some account of the work that had been done in Great Britain in obtaining small holdings of recent years, and Mr. Beach Thomas described the evidence he had received as to the widespread desire of city workers to get back to the land. An animated discussion followed, a little political, perhaps, at times, and not wholly devoid of rhetorical heat, but still informing; the general impression which seemed to emerge was that success is being attained by market gardening and fruit growing rather than by small farming. The president showed that in many cases, especially in Ireland, it is the community rather than the individual who should be the small holder, thus automatically ensuring cooperation both in the work and the trading.

The last meeting was held jointly with the parent section of economics to hear various papers of a more general economic character. Dr. Graham Brooks discussed the moral effects of cooperation upon the workers, and Dr. Moritz Bonn, of Munich, examined the statistics relative to Irish agriculture to ascertain if the last twenty years of land reform had begun to effect any improvement in the productive power of the Irish occupier. Statistically he could detect but little change, a view for which he was somewhat fiercely taken to task by the politicians present. Statistical papers by Prof. J. Wilson and Mr. W. G. Adams terminated a very successful session of the subsection, at which the interest and attendance had been maintained from the first day until the last.

## METEOROLOGY IN AUSTRALIA.[1]

THE Commonwealth Bureau of Meteorology, Australia has now been in existence more than a year, and issued its first Bulletin a few months ago. This is an article on the "Climate and Meteorology of Australia," and is written by the Commonwealth meteorologist, Mr. H. A. Hunt. It contains some very interesting data with regard to the climate of the various capitals, and indicates that Adelaide is the driest and sunniest, and that Brisbane is the hottest, capital. The hottest region is in the northern part of West Australia, near the Marble Bar and Nullagine goldfields, where the maximum shade temperature often exceeds 100° for days and even weeks continuously.

The Northern Territory and Queensland receive their rain in the summer from the monsoonal depressions from the north-east. The southern parts of West Australia and South Australia benefit from the Antarctic depressions in winter. In Victoria and Tasmania the seasonal change of rainfall is not strongly marked. New South Wales gets most of its rain in the later summer and autumn.

The wettest place is Geraldton, in north-east Queensland, with an average yearly fall of 145 inches; the driest region is round Lake Eyre, where 10 inches in one year is exceptional, 5 inches being the average.

In discussing cyclones and storms, mention is made of the "Willy Willies" which afflict the north-west parts of West Australia. These are severe cyclones which apparently originate in the Cambridge Gulf and travel south-west and south along the line of the coast, or they cross the continent towards the Australian Bight. These storms cause great havoc, and are marked by torrential rains.

The "Southerly Burster" is peculiar to the eastern parts of Australia, and is a cold wind which always follows a period of hot weather. It is usually associated with the V-shaped depression between two anticyclones. These storms are usually first noted on the extreme south coast, and they travel northward at the rate of about twenty miles per hour. The velocity of the winds varies, sometimes reaching eighty miles per hour.

Winds of similar character to "Bursters" are the "Bora" on the east coast of the Adriatic, the "Mistral" in France, the "Northers" of Texas, and the "Pampero" in the Argentine. South Africa also has a wind of like nature and origin.

[1] "The Climate and Meteorology of Australia." (Reprinted from the "Year Book of the Commonwealth of Australia." Bulletin No. 1, issued March, 1908.) By H. A. Hunt.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—On the occasion of the visit of the members of the International Conference on Electrical Units, the Public Orator (Dr. Sandys) spoke as follows in presenting on October 17 the several distinguished recipients of the degree of Doctor of Science *honoris causa*:—

(1) Scandinaviam hodie nobis quasi praesentem reddit Upsalae et Holmiae alumnus insignis, qui "electrolysis" (ut aiunt) praesertim in provincia investigatorum omnium dux et signifer merito existimatur; qui scientiae chemicae in regione physica inter conditores praecipuos numeratur; qui e scientia illa praemium orbi terrarum toti propositum reportavit, cuius laudis inter participes illustres et Cancellarium nostrum et rei physicae Professorem nostrum esse gloriamur. Idem solis ipsius naturae inter exploratores patientissimus, tempestatum inter augures perspicacissimus, (ut Aristophanis verbis paullulum mutatis utar) *τῶν νῦν μετεωρολογούντων* quasi princeps iure optimo esse fertur.

Ergo Scientiarum Doctor hodie merito creatur scientiae chemicae in provincia physica Instituti Nobilis Scientiarum in Academia Regia Holmensi Rector, SVANTIUS AUGUSTUS ARRHENIUS.

(2) Francogallorum respublica maxima, nobis vicina, nobis amicitiae vinculis indies artioribus coniuncta, viri desideratissimi in vicem, successorem eius misit dignissimum, qui non modo inter Germanos sed etiam inter Francogallos educatus, Parisiensium in Universitate iam per annos duo et viginti scientiam physicam praeclare

p... est. Rerum Naturae quidem studiosis non ...otam est electrometron illud ab eodem inventum. ...m plurium oculis obversatae sunt imagines illae p...cherrimae in quibus lucis auxilio et colores varii et luminis ipsius spectrum (ut aiunt) accuratissime redduntur. Peritioribus autem nota sunt volumina, quae ab eo et audiendi et videndi rationi universae explicandae dedicata sunt, quae et vim caloris et vim electricam modulosque eius ordine lucido enuclearunt. In his modulis sollertissime metiendis, iuvat recordari Cancellarii nostri cum rationibus hospitis nostri hodierni rationes minutissime quadrare. Ceterum de re tam subtili non nostrum est hodie fusius disputare; oratoris vestri ex animo nondum excidit monitum illud Horatianum :—

"metiri se quemque suo modulo ac pede verum est."

Praesento vobis Francogallorum Instituti socium illustrem, GABRIELEM LIPPMANN.

(3) Etiam e republica maxima trans aequor Atlanticum, nobis coniunctissima, ad nos advectus est vir insignis, Washingtonii in urbe illustri mensurae et ponderis provinciae praepositus, qui pecuniae publicae summam ingentem sibi liberaliter creditam, et scientiae ipsius et populi industrii maximo cum fructu, his rebus omnibus ad normam accuratam redigendis dedicavit; qui quantum operariorum industriae scientiarum exquisita cognitio conferat, luculenter demonstravit. Non inter antiquos tantum sed etiam nostro in saeculo trans aequor Atlanticum cognitum est, Mercurio, Atlantis nepoti, negotiatorum omnium numini, Divam Minervam, scientiarum omnium reginam, sororem esse omnium dignissimam. Animi nostri fraterni in testimonium, eo libentius hodie salutamus virum eloquentem, quem etiam ipsum Atlantis nepotem facundum nominaverim, SAMUELEM WESLEY STRATTON.

(4) Olim Altonae natus, a Berolinensibus educatus et ab eisdem scientiae physicae ad cathedram revocatus, adest sonitus in aëre clausi velocitatis investigator clarissimus, qui itineris sui inter comites insigniores etiam Cancellarium nostrum numeravit. Idem rei magneticae phaenomena illa perquam impedita expedivit, quae Professor quidam noster postea *Hysteresis* nomine nuncupavit. Denique scientiae physicae Imperii totius Germanici Instituto celeberrimo praepositus, virorum magnorum successor magnus merito esse existimatur. Inter Doctores nostros honoris causa olim HELMHOLTZIUM numeravimus: hodie successorem eius recentissimum ordini eidem libenter addimus.

Doctorum nostrorum seriem claudit hodie scientiae physicae honoris causa Professor Berolinensis, AEMILIUS WARBURG.

A large number of specimens of timber, grown, many under forestry conditions, on the Brocklesby Estate, Lincolnshire, has recently been sent by Lord Yarborough to the forestry museum, which is temporarily housed in the botany school. No fewer than seventy-seven species of trees are represented in this donation. Although forestry, as a subject of instruction at Cambridge, only dates from October, 1907, the collection of timbers already acquired is considerable, and includes both home-grown and foreign specimens, some of which are extremely rare, as that of the Servian spruce, an almost extinct species, which is confined to the valley of the Drina, between Servia and Bosnia.

The Gedge prize has been awarded to E. Mellanby, of Emmanuel College, for his essay entitled "Creatin and Creatinin."

Prof. Pope announces a valuable gift of apparatus and chemicals which has been made to the university chemical laboratory by the master and fellows of Gonville and Caius College and the master and fellows of Sidney Sussex College upon the closing of the chemical laboratories in the two colleges.

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A CONFERENCE of fruit-growers will be held at the South-Eastern Agricultural College, Wye, Kent, on November 27, under the chairmanship of Mr. C. W. Radcliffe Cooke, president of the National Association of English Cidermakers. Insecticides will be discussed by Mr. Spencer Pickering, F.R.S., spraying and spraying machinery by Mr. E. S. Salmon, grading and packing by a representative from British Columbia.

SOME two years ago the governors of the Sir John Cass Institute decided, in view of the great importance of the fermentation industries and the fact that there was very little methodical instruction available in London for those who were occupied in breweries and distilleries, to institute a course upon the chemistry of fermentation, and they appointed Mr. Arthur R. Ling to conduct this course. They have now broadened the basis of the work; and over and above the laboratory course in brewing and malting Dr. A. Harden will, during the winter, give a course of instruction in the micro-biology of the fermentation industries, which will consist of lectures and demonstrations. The first of this course was delivered on October 6, when Dr. Horace Brown, F.R.S., occupied the chair. In his opening remarks the chairman alluded to the value of scientific research, and said that there appears to be a considerable amount of misconception in the lay mind as to the meaning of the treatment of scientific research, and perhaps a still greater misconception in the methods employed in furthering it. The popular belief at present in vogue is that the scientific worker, in the first place, looks round for some great problem which calls for solution, and then proceeds by a series of experiments af trial and error to cut deep into the heart of the subject. Occasionally this method, if carried out, may lead to results, but he would rather suggest that research consists in finding some loose thread in the frayed edge of a piece of embroidery and in patiently following up the slender clue wheresoever it may lead, thus gradually revealing the elaborate pattern and the manner in which it is interwoven. Dr. Harden in his lecture first traced the history of the progress of knowledge with regard to alcoholic fermentation, referring to the work of Lavoisier Liebig, Pasteur, and Buchner. Working with Mr. Young at the Lister Institute, he found that phosphates gradually increase the rate of fermentation, a definite chemical reaction taking place in which the amount of carbonic acid exactly equivalent to the phosphate added is evolved, the phosphate itself entering into combination with the second molecule of sugar. Finally, a short account was given of recent work on the fermenting complex present in yeast-juice. Dr. Harden and Mr. Young consider this to consist of two distinct substances—the enzyme and co-enzyme—the cooperation of which is necessary to produce fermentation when added to a solution of sugar and a phosphate.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, June 4.—"Note on a New Sounding Machine for use on Lakes and Rivers without a Boat." By Prof. E. J. **Garwood**. Communicated by Prof. T. G. Bonney, F.R.S.

The sounding machine was designed specially for use on mountain lakes and rivers where boats cannot be obtained, but it can also be used with a boat, in which case it has the advantage over the sounding machines usually employed, since it registers the position as well as the depth of each sounding.

The instrument consists of two posts which are erected on opposite sides of a lake or river; between them a line is stretched, the ends of which are wound on drums carried by the posts. By alternately winding this line on each post a float is drawn backwards and forwards across the lake, the position of the float at any moment being automatically registered on the post worked by the observer. The float carries a pulley over which the plummet line travels, the end of this line being wound on a second drum attached to the observer's post. In this way rows of soundings can be taken across the lake, one of the posts being moved each time that the float reaches the shore until the whole lake has been charted.

By a mechanical device one counting machine is made to register both the depth of each sounding and the distance from the shore at which it is taken; it is also engraved with a double set of figures counting in opposite directions, so that observations can be taken in whichever direction the float is travelling. The instrument is supplied with a check and also a stop brake, and mechanical devices are provided to insure the constant tension of the line, and for preventing unequal piling of the line on the two drums.

There is also a special lever, by means of which the counting discs can be disengaged and returned rapidly to zero, the lines meanwhile remaining at rest. An important point in the practical working of the instrument is the fact that all mechanism is confined to the observer's post, so that any unskilled assistant can be utilised.

The instrument is portable, and can be carried by one man even in mountainous districts.

June 18.—"The Giant Nerve Cells and Fibres of *Halla parthenopeia*." By Dr. J. H. **Ashworth.** Communicated by Prof. J. C. Ewart, F.R.S.

An anterior and a posterior series of giant cells are present in Halla; the following statement refers to the anterior series. Primary giant cells are formed in segmental couples—one couple in each of the anterior ganglia of the nerve cord—until a maximum of eight couples is attained. Secondary giant cells are also formed at the anterior end of the nerve cord, and occasionally in one or more ganglia already possessing a primary couple. There is a progressive increase in the size of the primary giant cells until the worm has attained a length of 30 cm. to 40 cm. Yellow granules, probably insoluble products of metabolism, are present in the giant cells. Chromophilous granules occur in great abundance in a specialised peri-nuclear zone, distinguishable in the living cell by its greater refringency.

The neurofibrillar network in the giant cell is divisible into a peri-nuclear network, situated at the margin of the peri-nuclear zone, and a more extensive, wider meshed, and generally more slender stranded network in the general protoplasm. From this network slender primitive fibrils pass into the cone of origin of the axone, whence stouter fibrils, each due to the fusion of several primitive fibrils, pass into the giant fibre. The bundle of neurofibrillæ occupies from one-fourth to three-fourths of the internal diameter of the giant fibre.

The anterior giant cells of *Aglaurides fulgida* agree in the main features of their arrangement and structure with those of Halla.

**Entomological Society,** October 7.—Mr. C. O. Waterhouse, president, in the chair.—*Exhibits.*—W. G. **Sheldon**: Butterflies from Andalusia taken in the spring of this year. They included *Anthocharis belemia* and var. *glauce*; *A. tagis*, low-level and high-level forms; *Zegris eupheme*, var. *meridionalis*; *Melitaea phoebe*, var. *occitanica*; *M. deione*, a very large and well-marked form; and *Melanargia ines* with one striking aberration showing a strong melanic tendency.—Dr. Herbert **Charles**: Remarkable aberration of *Dryas paphia*, taken in the New Forest in July. With the exception of the borders and the bars, all the upper sides of the wings were suffused with deep velvety-brown triangular patches, the maculations being entirely absorbed therein.—Hugh **Main**: living larvæ of *Blatta germanica* to illustrate their colourless condition on first emergence.—H. St. J. **Donisthorpe**: Examples of (*a*) *Agrilus biguttatus*, F., from Sherwood Forest, not taken in Britain for about thirty years; (*b*) *Pyropterus affinis*, not uncommon in Sherwood Forest, July; (*c*) a species of Phora, with pupæ bred from larvæ which came out of the body of a *Clerus formicarius* taken alive in Sherwood Forest, July, with the Agrilus, and probably parasitic on it; (*d*) *Trogolinus anglicanus*, Shp., a specimen taken at Bembridge, August 3, with a specimen from Plymouth, only known before to occur in New Zealand and at Plymouth; (*e*) *Phyto melanocephala*, Mg., bred from wood-lice taken at Bembridge, Isle of Wight, August, with pupæ, and a wood-louse with dipterous pupa *in situ*. The life-history of the fly was hitherto unknown, though the larvæ of *Rhinophora atramentaria*, Mg., a nearly related species, have been recorded as parasitic on *Oniscus asellus*.—A. **Harrison**: A gynandromorphous example of *Pieris napi*, bred from parents taken in north Cornwall this year.—E. R. **Speyer**: Rare and interesting dragon-flies taken in the British Isles in 1908, including *Sympetrum fonscolombii*, Selys, ♂ and ♀, taken in Hertfordshire on June 24 and July 27 respectively; *Somatochlora metallica*, Lind., a ♂ captured in Sussex on August 4, being the first authentic record of this insect in England; and *Libellula quadrimaculata*, Linn., four specimens, showing the remarkable difference in the amount of suffusion on the wings in individuals.—Norman **Joy**: Examples of Coleoptera new to the British list.—H. M. **Edelsten**: Specimens of *Aeschna isosceles* and *Libellula fulva* from Norfolk Broads, taken in June, and *Orthetrum caerulescens* from Chagford, taken in July.—W. J. **Lucas**: A spike of the grass *Molinia caerulea* with dead Syrphids, *Melanostoma scalare*, Fabr., attacked by the parasitic fungus *Empusa muscae*, found on Esher Common, October 3. Many or most were attached by the point of the head only in a very peculiar manner, and apparently all were females.—O. E. **Janson**: A specimen of *Cryptamorpha desjardinsi*, Guér., found by Mr. F. C. Selous at Barton-on-Sea, Hants. This beetle is recorded as living on banana plants in Mauritius and Madeira, and may have been introduced here in the banana fruit.—W. **West**: Specimens of the following insects:—*Alcochara crassiuscula*, Sahlb., taken at Great Yarmouth in May; varieties of *Donacia dentipes* and *D. simplex*, from Caistor Marshes; *Nabis boops*, Schiödte, taken at Esher in August; and *Idiocerus scurra*, Germ., taken at Blackheath, Kent, in September.—L. W. **Newman**: Specimens of (*a*) *Crymodes exulis* from the Shetlands, including one of the very rare female; (*b*) *Callimorpha dominula*, two yellow aberrations bred from east Kent ova; and (*c*) a varied series of *Camptogramma fluviata*.—Dr. F. A. **Dixey**: A number of Central and South American butterflies belonging to six different subfamilies, but all showing the same obvious character of a diagonal reddish band on a general dark surface.—*Papers.*—Bionomics of butterflies: Dr. G. B. **Longstaff.**—Some additions to the Perlidæ, Neuroptera-Planipennia, and Trichoptera of New Zealand: L. J. **Hare.**—The larvæ of *Hamanumida daedalus*, Fab., *Hoplitis phyllocampa*, n.sp., and *Sulophonotus myrmeleon*, Feld, with descriptions of the imagines of the two Heterocera: Roland **Trimen.**—Revision of the Australian and Tasmanian Malacodermidæ: A. M. **Lea.**

**Institution of Mining and Metallurgy,** October 15.—Mr. Alfred James, president, in the chair.—The separation of metallic ores by jigging: A. **Taylor.** A description of a modification of the ordinary mechanical jig, devised by the author, in which a vibrator is substituted for the usual plunger. The vibrator consists of a shaft provided with discs or fly-wheels so constructed that their centres of gravity do not coincide with that of the shaft to which the hutch is attached; consequently the revolution of the shaft and hutch carrying the screen, in accordance with the law which compels a rapidly revolving mass to rotate around its centre of gravity when uncontrolled by fixed bearings. In this case the whole apparatus is hung on springs, allowing of free vibration in any direction. The paper contains also a description of the ores for the special treatment of which the apparatus was primarily designed.—Laboratory routine in modern smelters: H. T. **Waller.** A brief description of methods found useful by the author in connection with copper blast-furnace smelting. These include the analyses of slags and matte, and determinations of copper, iron, silica, lime, aluminium oxide, zinc, and sulphur.—Reinforced concrete foundations for stamp batteries: S. J. **Truscott** and J. P. **Fuller.** A detailed account of the replacement of the original wooden mortar blocks of the stamp battery at Redjang Lebong, Sumatra, by others constructed of reinforced concrete, with notes on the composition of the materials used and the cost of the work.—The estimation of sulpho- and ferrocyanides, &c., in cyanide solutions containing copper: L. M. **Green.** This paper deals with the complications arising from the presence of copper in solutions obtained in the cyanide treatment of silver and gold ores in regard to the determination of sulpho- and ferrocyanides. Cupric and cuprous double cyanides exercise a reducing action on permanganate in acid solution, and precipitate both sulpho- and ferrocyanides, so that an ordinary method of determination is often impossible. The paper describes some of the reactions and tests to be adopted in these circumstances.—Mine sampling devices: H. E. **Hooper.** Two devices, a hanging sampling chair for use in winzes, and a catching bag for employment in conjunction with the chair, are here briefly described and illustrated.

Paris.

Academy of Sciences, October 12.—M. Bouchard in the chair.—A statement of the conditions under which the Bonaparte fund will be applied.—The application to man of an anti-tuberculous serum: MM. **Lannelongue, Achard,** and **Gaillard.** The serum is prepared from horses and asses, after submitting the animals to the action of a toxin extracted from the tubercle bacillus. Preliminary experiments on animals appeared to show some beneficial effects, and an account is now given of the treatment of human tuberculous subjects with this serum. The experiments have lasted more than a year, more than fifty subjects affected with various tuberculous diseases having submitted to the treatment. The serum is well tolerated, and can be used without danger; it is without curative influence on cases of advanced tuberculosis, but in less advanced cases forms a useful addition to the usual therapeutic treatment. In some cases the number of tubercle bacilli was shown to diminish and even disappear.—Cultural bud mutations in *Solanum Maglia*: Edouard **Heckel.** This variety offers certain advantages over *Solanum tuberosum* in its resistance to mildew, does not require a soil specially resistant to drought, and accommodates itself to soils containing large amounts of clay and lime.—The Tempel-Swift comet: MM. **Javelle** and **Giacobini.** Observations of the comet were made at Nice on the nights of September 29, 30, and October 2 and 3. The mean positions of the comparison stars and the apparent positions of the comet are given.—Remarks on a note of M. Lebedew relating to the dispersion of light in interstellar space: Charles **Nordmann.**—Systems of families of surfaces cutting along conjugate lines: S. **Carrus.**—The extraction of the rare gases of the atmosphere: Georges **Claude.** A description, with diagram, of a modification of the commercial apparatus for separating oxygen and nitrogen by fractional distillation for the purpose of extracting the lighter gases of the atmosphere. The modified apparatus gives a continuous flow of a gaseous mixture consisting of nitrogen with at least 50 per cent. of neon, helium, and hydrogen. Another modification gave a gas with a density of 0·68 that of air; since the density of neon is 0·69, the gas thus obtained is extremely rich in neon. Approximately pure neon can in this way be obtained in any quantity.—Researches on the diffusion of gaseous ions: Edouard **Salles.**—The method of calculation of the atomic weights: Louis **Dubreuil.** A discussion and modification of the methods of Hinrichs.—One of the causes modifying the dominant forms in crystals, and on solid solutions: Paul **Gaubert.** It is shown that in the crystallisation of phthalic acid the addition of small quantities of liquids to the solvent causes modifications in the form of the crystals separating on cooling. It is known that a crystal, growing in a liquid, can absorb molecules of another crystalline substance, and to this must now be added the molecules of the solvent itself or of another liquid present in the solvent.—Katafa, Geaya, and Macrocalyx, three new Madagascan plants: M. **Costantin** and H. **Poisson.**—The skeleton of the anterior member of *Bradypus torquatus*: A. **Menegaux.**—The phenomena of phagocytosis and autodigestion in the course of the regression of the ascidiozoids in the Diplosomideæ (compound ascidians): Antoine **Pizon.**—Crossing in the Amphibia from the cytological point of view: E. **Bataillon.**—Anatomical orientation in radiography: A. **Rieffel** and Maxime **Ménard.** The incorrect placing of the Crookes's tube may result in apparent displacements, deformations, or lesions, or, conversely, may mask these if present.—Contribution to the study of audition: M. **Marage.** A comparison of the theory of Helmholtz and that according to which all the nerve centres are equally impressed; the latter theory is held to correspond most closely with the most recent anatomical and pathological knowledge.—The resistance at 100° C. of the hæmolysins of prepared serums. The separation of alexine and its sensitiser by filtration through collodion: Albert **Frouin.**—The treatment of trypanosomiasis in horses by orpiment alone or associated with atoxyl: A. **Thiroux** and L. **Teppaz.** *T. cazalboui* and *T. dimorphon* have been successfully treated by the combination of orpiment with atoxyl, all the three horses treated being cured. It is possible that m'bori is also curable by this treatment. Two horses suffering from souma have been treated with success by orpiment alone.—The persistence throughout Corsica of a zone of abnormal contacts between the eastern and western region: M. **Deprat.**—Disturbances in the electric charge of the earth: Albert **Nodon.**—Variations of latitude and earthquakes: M. de Montessus **de Ballore.**

## DIARY OF SOCIETIES.

*THURSDAY*, October 22.

Chemical Society, at 8.30.—The Passage of Hydrogen through a Palladium Septum, and the Pressure which it produces: D. Tsakalotos.—The Relationship of Colour and Fluorescence to Constitution, Part ii., Rhodamines of Mellitic Acid: O. Silberrad and C. S. Roy.—Constitution of the Fluorescences of Mellitic and Pyromellitic Acid: O. Silberrad.—A New Form of Gas Burette: A. E. Hill.—A Molecular Compound of Trinitroacetaminophenol and β-Naphthol: R. Meldola and J. G. Hay.—Reduction Products of Azoxybenzene, Preliminary Notice: L. H. Berry.—Constitution of the Salts of the Phthaleins, and the Cause of Colour in the Triphenylmethane Series: A. G. Green.—Chlorination of *p*-Nitraniline: B. Flürscheim.—Relation between Absorption Spectra and Chemical Constitution, Part x., Unsaturated Acids of the Benzene Series: E. C. C. Baly and K. Schaefer.—Condensations with Monochloromethyl Ether, Part i., Condensation of Monochloromethyl Ether with Ethyl Malonate and Ethyl Isopropyl Malonate: J. L. Simonsen.—Relation between Chemical Constitution and Physiological Action in Certain Substituted Aminoalkylesters: F. L. Pyman.—Effect of Constitution on the Optical Rotatory Power of Optically Active Nitrogen Compounds, Part iii.: R. W. Everatt and H. O. Jones.

*FRIDAY*, October 23.

Physical Society (National Physical Laboratory), at 3.30.—Demonstrations of Work in Progress in the Laboratory.

*WEDNESDAY*, October 28.

Society of Dyers and Colourists, at 8. Some Recent Improvements in Dyeing and Cleaning: F. J. Farrell.
British Astronomical Association, at 5.—Annual Meeting.

## CONTENTS.

THURSDAY, OCTOBER 29, 1908.

## FARM ANIMALS.

*Cyclopedia of American Agriculture.* A Popular Survey of Agricultural Conditions, Practices, and Ideals in the United States and Canada. Edited by L. H. Bailey. Vol. iii., Animals. Pp. xvi+708. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1908.) Price 21*s.* net.

THE third volume of this important "Cyclopedia of Agriculture"—the volume dealing with animals—reflects in a remarkable manner the varying standards to which agricultural knowledge has attained in individual sections of the subject. In the sections hitherto most amenable to experiment and research a vast amount of information of an accurate and trustworthy character has been accumulated. Much of this information may be beyond the farmer's capacity to utilise; some of it may have been developed on lines which were not always as useful as the experimenters expected and claimed; but time and experience always tend to bring the experimenter in the laboratory and the operator in the field into closer and closer touch, and so to rub off the eccentricities of each. On the other hand, in the sections concerned with breeding and selection, and with the evolution of different types of stock, our knowledge is still in a very nebulous condition, even though in these sections agriculturists have operated with, perhaps, the greatest apparent success. In dealing with such subjects, writers are still too apt to lay the foundations of their work in unquestioned beliefs and unsubstantiated opinions. Such expressions as "it is supposed," "it is believed," "it is said," "it has been thought," appear in this volume, as in most other books upon the same subject, with too great frequency. It is unfortunate that, instead of emulating the patience and thoroughness of such authors as Youatt and Low, our recent writers on live stock have taken to a style that may be descriptively interesting, but is often inaccurate, sometimes even slip-shod, and leads to no abiding result.

The editor of this encyclopædia realises the unsatisfactory nature of this part of the work compared with the other part based upon long-continued experiment and research, and his words are well worth quoting:—

"Contrary to his expectation, the editor has found the compilation of this volume much more difficult than the making of the volume on crops. Animals are less tractable to investigate than plants, and the scientific method does not seem to have been so successfully applied to the study of them as to crops. In the matter of breeds, the expert knowledge is likely to be in possession of advocates or even of partisans, and it is very difficult to arrive at agreement or a common basis of comparison and judgment. Existing writings are largely descriptive and historical. Even on questions of feeding and general management, there are almost irreconcilable differences of opinion. The editor hopes, however, that the compilation has brought together the soundest opinions and practices, and he is sure that the names of the contributors to this volume will make the work authoritative. The articles on breeds are largely from men engaged in practice and from specialists in the breed, whereas the articles on crops in vol. ii. are largely from teachers and investigators; this dissimilarity is representative of the kinds of interest that attach to these two groups of agricultural produce."

It would be almost impossible to overestimate the value of the real scientific part of this volume, such, for instance, as Armsby's chapter on the principles of stock-feeding, the complementary chapters on balancing rations, and the whole section dealing with the manufacture of animal products, in which milk, butter, cheese, meat, and even such things as hides and leather are dealt with. There are very useful and carefully written chapters on the physiology of domestic animals, on infectious diseases of animals, and on the American invention of scoring-cards in stock-judging.

The greater part of the work is taken up with a description of North American farm animals, their breeding, history, rearing, and general treatment towards accomplishing the ends for which they are intended. This part must be useful to a very large number of people, for it treats not only of horses, cattle, sheep, and swine, but of dogs, goats, fish, poultry, reindeer, and bison, and even of pigeons, rabbits, cage-birds, and many other domestic pets.

It is only in the parts of the book dealing with the science of breeding and in the descriptions of individual breeds that we would suggest amendments. In so important a "Cyclopedia" as this, one expects the writers on breeding and heredity to go beyond the Darwinian position and discuss the illumination which the work of such men as Weismann, De Vries, and Mendel has afforded. One also expects doubtful theories to be well sifted. For instance, a reconstructed Urus is labelled "Urus, the source of domestic cattle." The question is no doubt encompassed by many difficulties, but it would be just about as easy to prove that the quagga is the source of domestic horses.

Perhaps the best way to indicate the kind of statement to be found running through the breed descriptions is to throw a few of them into the form of interrogations while retaining the writers' language as far as possible, viz.:—

Did Hugh Watson declare himself for the "Black and all black; the Angus Doddie, and no surrender"? Is Angusshire now a part of Forfarshire? Did Watson's ancestors breed Angus cattle on the Keillor farm for more than two hundred years before 1805? Did Hugh Watson begin to breed Angus cattle in 1805? Are there Devon cattle in Ireland? Is the Galloway the oldest of the pure breeds of Britain? Is the Hereford among the oldest, if not the oldest, established of the English breeds of domestic cattle? Have Suffolk or polled cattle existed in the county of Suffolk, England, from time immemorial, and does the probability seem to be that they were introduced soon after the Roman occupation? Is the supposition correct that a Mr.

Dexter developed the Dexter breed of cattle by crossing the true Kerries on cattle of a beefy sort, possibly Shorthorns? Was the cow called *Red Rose* which produced nearly 10,000 lb. of milk in a year a true Kerry? Is the cow figured on p. 380 as a Dexter-Kerry really a Dexter-Kerry? Is the outcome of the cross of Shorthorn bulls on Galloway cows usually a blue-grey? Did the monks of the Middle Ages have the Cheviot breed of sheep about the pasture-lands of the old monasteries? Did George Washington have Bakewell ewes at Mount Vernon, or is it only "said"? Do black-faced sheep subsist largely on heather?

The answers to some of these questions may be in the affirmative, but they need support before being accepted.

There are two breeds of cattle peculiar to America, viz. the polled Durhams and the polled Herefords, about the origin of which one would like to have definite information. In both these breeds there are what are called "double standards" and "single standards": the "double standard" animals being pure-bred hornless sports and their descendants, and the "single standards," in the case of the Hereford, being animals "not eligible to record in the American Hereford Record," and, in the case of the Shorthorns, animals "got by the use of Shorthorn bulls on the native muley cows." We never hear of hornless sports among pure-bred Herefords or Shorthorns in Britain, and some information as to the circumstances in which these occur in America would be not only interesting, but useful to students of heredity.

James Wilson.

## POWER GAS PRODUCTION.

*Power Gas Producers, their Design and Application.* By Philip W. Robson. Pp. iv+247. (London: E. Arnold, 1908.) Price 10*s.* 6*d.* net.

THE wonderful advance in the production of power made by the suction gas plant combined with the gas engine gives great importance to any trustworthy literature on the subject, and the work on power gas producers by Mr. P. W. Robson is certainly one which will be warmly welcomed, as it sets the subject out in a clear and concise manner, and indicates the theory of the various actions, as well as the means by which the application is carried out.

As the author very fairly admits, it is difficult for one engaged in the manufacture of a particular class of producer to treat thoroughly of the work of other firms, with the result that perhaps full justice has not been done in every case; but as a whole the book is wonderfully free from error, although there are a few points which might be amended.

The statement made on p. 17 that anthracite and gas coke have practically the same proportion of volatile matter is a little loose, as with a good gas coke one does not expect to find more than 1 per cent., whilst the average in anthracite is about 5 per cent. to 6 per cent. On p. 29 the reader is left to infer that, inasmuch as a temperature of 900° C. to 1000° C. favours the formation of carbon monoxide rather than the dioxide, it is the best to employ, whilst practical conditions undoubtedly dictate a lower temperature in order to avoid the tendency to clinker which is so often found with fuels that are not of quite the best quality. Indeed, some of the largest producer makers hold that a temperature between 800° C. and 900° C. is the best for practical working.

In the conclusion to this chapter, also, the statement that an excessive amount of steam lowers the temperature all round and is generally against efficiency, preventing the production of a good gas, is of course modified by the fact that within a fairly wide range increase of carbon dioxide almost invariably means a corresponding increase of hydrogen, and if this were not so it is quite clear that such processes as the Mond would not be possible, whilst the advantage of an excess of steam over the theoretical quantity is in reduction of clinker and ensuring free combustion of that portion of the carbon which otherwise remains in the ash.

In chapter iii. the statement is made that the regulation of the steam is unnecessary, and in producers of the "National" type this may be the case, as it would be very difficult indeed to regulate a water feed which has to distribute over half a dozen places, but with other forms of producer it is certain that if a less saturation of the air is arranged for low loads and is increased in an increasing ratio at full loads, a more uniform temperature is maintained in the generator.

On p. 46 indicator diagrams are shown of the National and Crossley engines as illustrating conclusively that the gas produced with excess of steam could not have been of such high calorific value as that evolved in the National type of producer, but the author has evidently overlooked the fact that in the trial here quoted the National engine was taking full gas, whilst the Crossley engine had the gas charge throttled so as to keep within the limits of power of the trial.

It is stated on p. 71 that the temperature of the gas entering the cooling or coke scrubber should be 600° F., but this temperature would be with ordinary plants far too high, and would be taken as showing that in the form of vapouriser used the heat was not properly extracted.

The author mentions on p. 106 that some French makers have introduced a chemical purifier containing oxide of iron for the purpose of eliminating sulphuretted hydrogen from the gas, but surely it is unnecessary to give credit for what has been done in every gas works for very many years.

On the last line but one of p. 84 "per hour" should be inserted after "7½ gallons," whilst in the table on p. 136 the higher value of the heat efficiency for the whole run should be 80 per cent. instead of 8 per cent., and there is a misprint on the third line from the bottom of p. 221.

The portions of Mr. Robson's work which deal with bituminous gas plants are not nearly so good as those portions that have reference to the use of anthracite and coke, whilst the chapters on work and management are clearly based on knowledge gained with the National type of producer, and would not in every case be applicable to another form.

The description on p. 56 of the arrangements in the Crossley plant for varying the entering mixture is not very clear, and throughout the book but little is said of the generators produced by this firm, and it is limitations of this kind which are the chief fault that can be urged against an otherwise admirable book.

## THE NATIONAL COLLECTION OF FISHES

*Guide to the Gallery of Fishes in the Department of Zoology of the British Museum (Natural History), Cromwell Road, London, S.W.* Pp. v+209. (London: Printed for the Trustees, 1908.) Price 1*s*.

THE unique collection described in this guide consists mainly of stuffed specimens, coloured, as far as possible, to resemble the fishes in their natural conditions. "I believe," says the director in the preface, "that there is no other collection of fishes in a public museum in which the specimens are presented without the usual iron supports, with sufficient space around each fish and in natural colours, instead of the oily-brown which all dried fishes tend to acquire." All preserved material is kept in a separate building, where it is accessible only to special applicants. This arrangement is very desirable, since arrays of jars displaying mystifying anatomical details merely serve to distract the general student of fishes who wishes to devote his attention to the external features of as many species as possible, acquiring, at the same time, such information about each as will enable him to understand their natural relationships, their places in the economy of nature, and the special character and variety of fish-life in all its aspects. This is the chief object of the collection, and of the descriptive labels attached to each specimen case. "This guide is a collection of the labels with some additions, arranged systematically so as to show the groups into which fishes are divided, and is illustrated by figures which are to a large extent taken from photographs of the specimens actually seen in the cases."

The variety and interesting character of the information given in this guide is fairly illustrated by the following samples:—

"The Herring, *Clupea harengus*, 255, is found on both European and American sides of the North Atlantic, and is especially abundant in the North Sea and off Norway. It may thus be regarded as a northern and a cold-water fish. The 'Herring' of the North Pacific is of another species, *Clupea pallasi*. The Herring fisheries of the North Sea take place during the spawning season, which reaches its height in June off Shetland, and in November off Lowestoft. The fishing fleets move southwards as the centre of shoaling shifts from point to point. The spawn of the Herring, unlike that of most food fishes, even the allied Pilchard and Sprat, sinks to the bottom; but the fish are mostly caught near the surface in drift-nets, which may be more than a mile in length for each boat. About 8,000,000 cwt. of Herrings, valued at more than 2,000,000*l*., are annually landed in Great Britain. The largest Herrings come from Loch Fyne, in Scotland."

"The Sea-breams and Snappers belong to the family Sparidæ; they are coast fishes, widely distributed, and mostly carnivorous. The spinous and soft portions of the dorsal fin are continuous and nearly equal in extent; the lower rays of the pectoral fin are branched; the lower pharyngeal bones are separate. The genera of the family are distinguished the one from the other chiefly by the characters of the teeth."

In view of the recent rapid growth of our knowledge and increasing public concern regarding our food-fishes, it is not surprising that special attention has lately been devoted by the keepers of the gallery to these fishes. They are distinguished from other fishes by the letters B.F.F. (British Food Fish), while the descriptive labels attached to each specimen give the latest information (repeated in this guide) concerning its economic importance and value, the principal fishing grounds, means of capture, food, and habits.

Altogether, it may safely be said that a student who conscientiously examines the fish series in the national collection and who assimilates the information contained in this guide will acquire an accurate, vivid, and comprehensive knowledge of the world of fishes, a possession not only valuable in itself, but the best possible foundation for more special studies.

W. W.

## THE RESISTANCE AND PROPULSION OF SHIPS.

*Hydraulics.* In two vols. Vol. ii., The Resistance and Propulsion of Ships. By Prof. Dunkerley. Pp. iv+253. (London: Longmans, Green and Co., 1908.) Price 10*s*. 6*d*. net.

THIS is the second volume of a treatise on hydraulics written by the author. Its origin may be traced to his previous service as professor of applied mechanics in the Royal Naval College at Greenwich, where students of naval architecture and marine engineering taking advanced courses receive instruction in the resistance and propulsion of ships. A good text-book on these subjects, bringing information up to date, has been much needed, and this volume (of about 250 pages) will be welcomed. It brings together in a clear and compact form the modern theories of stream-lines and wave-motion, and summarises experimental investigations on resistance and propulsion, thus sparing readers the labour and trouble incidental to personal research in many and scattered publications containing the original papers of Rankine, William Froude, Scott Russell, Cotterill, R. E. Froude, and other authorities. The mathematical parts of the book are well written, and the descriptive sections are interesting; numerous diagrams assist the explanations. Practical applications of scientific methods to the design of steamships and their propellers find a place, although no attempt is made to intrude on the special province of the naval architect and marine engineer. In these sections of the book considerable use is made of information published in the Transactions of the Institution of Naval Architects and other technical publications, always with due acknowledgment.

There are six chapters. The first deals with "stream-lines," mainly following Rankine's methods, but also discussing Prof. Hele Shaw's interesting experiments on viscous stream-line flow and Sir George Stokes's mathematical investigations thereon. Next an excellent summary is given of the theory of wave-motion; for waves of translation and oscillation, and for capillary waves. Methods of observing ocean waves, and some results of such observations, are also described. In this section reference is made to original work done by Prof. Osborne Reynolds in connection with groups of waves.

Two interesting chapters—making up about one-fourth of the book—are devoted to an epitome of modern methods of determining the resistance of ships, due for the most part to the work of William Froude, whose enunciation of the "law of comparison" between ships and models, and investigations of frictional, eddy-making, and wave-making resistance are described in detail. Since the system of model-experiments was introduced by Froude about forty years ago, great extensions have taken place in the trials made with full-sized ships, and the comparisons of the results of such trials with those obtained with model ships and propellers have yielded much valuable information. This result is illustrated in many ways by the author, in a chapter dealing with the trials of ships. Considerable interest will be taken in the discussion of the influence which *depth of water* has upon the resistance of ships, especially in view of certain extraordinary results obtained on the trials of some recent torpedo-boat destroyers. In a final chapter the characteristics and relative efficiencies of water-jet propellers, paddle wheels, and screw propellers are discussed at length, the work of the two Froudes, Rankine, Cotterill, and Charles Parsons being utilised. No part of the book shows greater labour than this in its assemblage and analysis of facts and theories. A good index completes the volume.

On its merits the book deserves, and will receive, favourable recognition from all interested in the subjects of which it treats. That recognition will not be lessened by the fact that its appearance is coincident with a serious breakdown in health of its gifted author, involving his resignation of the professorship of civil and mechanical engineering in the University of Manchester. To this circumstance may be attributed certain errors in mathematical formulæ occurring in the book, and these should be corrected in future editions. There is evidence, too, that the book was, for the most part, completed some time ago; as it gives no account of valuable experimental investigations made during the last two or three years in this country and the United States. As it stands it may be recommended as a text-book for the use of students, working under the guidance of competent teachers.

## STUDIES IN THE STATISTICS OF PRODUCTION.

*Kraft: Ökonomische, technische und kulturgeschichtliche Studien über die Machtentfaltung der Staaten.* By Prof. E. Reyer. Pp. xvi+380. (Leipzig: W. Engelmann, 1908.) Price 6 marks.

THE subject with which Dr. Reyer deals in this volume is an extremely wide one, viz. "the supply and consumption of human, animal and mechanical and thermal energy for domestic purposes and in agriculture, industry and transport." Practically speaking, the subject, as he interprets it, is coterminous with what is usually understood by the statistics of production, and we cannot help thinking that some such title would have better described the work. Dr. Reyer deals not merely, or even principally, with statistics of power as such, but with the means of obtaining heat and power, the uses to which it is put, and even the organisation of industry. The replacement of handwork by wholesale manufacture, the output of coal, the development in the use of steel, transport by land and sea, agriculture, gas and electric lighting all come under his survey.

The labour that Dr. Reyer must have spent on his work and on the preparation of the numerous illustrative diagrams is immense, and some of his studies serve to emphasise very well the great changes that have taken place of recent years in the industries of the world, and more especially in the relative positions of Germany, Great Britain, and the United States—the three countries to which the author devotes most of his attention. Taking the volume as a whole, however, we do not think that Dr. Reyer can be said to have fulfilled his task very happily, though it will be readily conceded that many difficulties are inherent in the subject. The data are very imperfect, usually incomplete, and nearly always incomparable as between one country and another. Still, there are data, and the volume might, we think, have been made both more readable and more useful to the student.

In the first place, the chapters read as if they were isolated studies, made at different times, and subsequently thrown together with little or no attempt at arrangement. The first three are entitled "The Age of Steel," "Mining and the Importance of Coal," and "The Noble Metals" respectively, and form to some extent a connected series. The reader expects the following chapters to deal with other industries, but chapter iv. treats of the growth of population and development of industry in the case of the Great Powers, chapter v. passes to the industries of a single country—the United States—chapter vi. gives a general discussion on the subject of wholesale manufacture and handwork, and the next chapter deals with economic fluctuations! After this we come to transport and then to agriculture. The book has no obvious structure or plan, and the erratic changes of subject are most distracting to the reader.

In the second place, references are almost entirely lacking. There are few or none in the text, and a hopelessly inadequate bibliography at the end of the volume, a bibliography which suggests that the author must have taken much of his information at second hand. Data of every degree of untrustworthiness are given in the text, but the student is debarred from verifying the figures or referring to the original for further information as to their meaning; exact references should have been given in every case. Even in the bibliography we would suggest that such citations as "Produktion and consum. of timbre in forein countries. (blue book)," and "Statesman's yearbook, Statist. Abstracts (mit statistischen Tabellen)," are hardly clear.

Finally, while we approve the use of graphic methods, we wish that Dr. Reyer would lay to heart the golden instruction in the Board of Education's "Syllabus of Practical Mathematics":—"In all the work on squared paper a candidate should be made to understand that an exercise is not completed until the scales and the names of the plotted quantities are clearly indicated on the paper."

## OUR BOOK SHELF.

*Etude sur la Vallée Lorraine de la Meuse.* By J. Vidal de la Blache. Pp. 190; with figures and folding maps. (Paris: Armand Colin, 1908.) Price 4 francs.

CAPTAIN VIDAL DE LA BLACHE publishes in this book a memoir on the development of the valley of the Meuse, a subject that has engaged the attention of several previous authors, including M. Cornet and Prof. W. M. Davis. He points out the striking character of this long valley, without any important tributaries, yet carved out in past times by a river more powerful than that which now occupies its bed. He explains its independence as regards the Paris basin by the fact that its waters were led northward into an old sea covering the Ardennes before the westward slope of the Seine system had been determined. The Meuse was originally joined by the Moselle at Pagny-sur-Meuse, through the now deserted gap between that town and Toul, and thus had its primary sources in the Vosges. The author relies much on the distribution of pebbles from the Vosges in the older alluvium of the valley. He denies that the river is decadent, though since the capture of the Moselle it has lost much of its erosive force; it has still an important flow, owing to the supplies gathered from the rains and stored in the deep and saturated gravels of its bed.

The second part of the book relates to the influence of the valley on the occupations of its inhabitants. The population has become reduced (p. 143) to the lowest level compatible with agricultural production, and labourers are even invited from other areas. Hence there is no surplus of workers who might emigrate from it to the neighbouring mining country. The latter has become occupied by Belgians and Italians, and the contrast of peoples and modes of living has become acute. The typical farmstead on the Meuse is figured on p. 151, where we see dwelling-house, barn, and stable under one great roof, as in Friesland; three separate entries, however, are here provided in place of the huge doorway common in the Low Countries. The history of roads along this natural highway or across it is fairly given, but the author stops short of the last great incident of the valley, when the French armies were led northward along it, as if drawn fatally to the Ardennes, while the Bavarians, representing the ancient torrents from the Vosges, poured down after them to Mouzon and Sedan. As Captain de la Blache observes (p. 177), the mineral wealth of Lorraine has led to a convergence of canals and railways independent of the direction of the Meuse; it is as if this valley "avait subi aussi une capture économique."

G. A. J. C.

*Chemical Reagents, their Purity and Tests.* A New and Improved Text based on the Latest Edition of Krauch's "Die Prüfung der chemischen Reagentien auf Reinheit." By E. Merck. Translated by H. Schenck. Pp. vii+250. (London: A. Constable and Co., Ltd., 1907.) Price 6s. net.

EVERY chemist, whether engaged in analytical work or not, will welcome the translation of Krauch's manual into English, for the growing refinements introduced into all chemical operations render a full knowledge of the purity of laboratory reagents increasingly important.

In the present volume the properties of common materials, both inorganic and organic, are given in alphabetical order, the nature of the impurities indicated, and the tests, both qualitative and quantitative, described. It thus becomes a very simple matter to ascertain the purity of any substance, and, as there are something like 250 enumerated, it will be seen that the range is fairly comprehensive. There is little that calls for comment or criticism. The descriptions of the impurities and tests, though short, are usually sufficient for the purpose, not the least valuable part being the references to original papers containing details of the processes not found in the text.

The original of Krauch's manual appeared in German in 1888, and passed through several editions, the above translation being made from a revised edition prepared by E. Merck in 1905. The names of the joint authors are a sufficient guarantee of the trustworthiness of the information, and the translation is all that could be desired. Whilst strongly recommending the book we would direct attention to a few omissions. There is no mention of hydrazine, formaldehyde, toluene, or titanium salts, no quantitative method given for estimating solutions of hydrogen sulphide and ammonium sulphide, and nothing is said about metallic lead, magnesium, and aluminium, all of which may be regarded as not uncommon reagents.

J. B. C.

*Notre Flotte aérienne.* By Wilfrid de Fonvielle and Georges Besançon. Pp. 234. (Paris: Gauthier-Villars, 1908.) Price 6.50 francs.

THIS little book forms a *résumé* of the steps taken to accomplish the navigation of the air so far as we have at present got. Ordinary ballooning is left out of the question, and the bulk of the book is devoted to the development of the dirigible, especially in France.

Soon after the ascent of the first balloon (1783), Lieutenant Meusnier wrote a memoir discussing the principles on which a dirigible balloon might be constructed. This was remarkable as foreshadowing the airship of to-day, especially as regards the "ballonet," or method by which the envelope can be kept rigid by the internal pressure of air. But at that period no engines existed by which the necessary power for propulsion could be obtained. Later on, when the steam engine had become developed, Giffard built his machine, the prototype of the modern vessel, and made trials in Paris in 1852. Little by little further improvements were made, the siege of Paris especially directing attention to the importance which might attach to such an apparatus in military operations.

Then came the electrically propelled balloons of MM. Tissandier, and *La France*, which latter proved to be the first machine to make long journeys successfully.

Finally we come to the "machines à explosion," or balloons propelled by gas engines. Paul Haenlein in 1865 was the pioneer of this type, although he seems to have had no practical success. The German machines of Woelfert, Schwartz, and the first Zeppelin are in turn described, though each of them proved failures. The various vessels of Santos Dumont next claim attention, especially his much-lauded trip round the Eiffel Tower. More failures and catastrophes followed with Rose, Severo, and De Bradsky, and then came the successful essays of the Lebaudys. The history of this type of airship is fully gone into, from the first trials up to the unfortunate escape of the *Patrie*.

Then follow descriptions of the other French dirigibles, the *Ville de Paris*, and that of Count de la Vaulx.

The modern airships of other countries are disposed of in a few pages. The Zeppelin No. 3 is shortly described, but its better-known successor, which has since made its *début* and taken its *congé*, is referred to in the final pages of the book. Having described the Polar explorations by balloon at some length, the authors give a chapter on aëroplanes. The latter can hardly be called up to date, since progress has been so rapid during the last year or two. It is almost amusing to read of M. Farman's record performance of remaining in the air for 52⅗ seconds when to-day we think nothing of Mr. Wright flying for more than an hour with a passenger. In these circumstances of kaleidoscopic changes it seems impossible to bring out a book on aëronautics which shall be really up-to-date, but the one before us is a good little history which is fairly trustworthy, though it is not detailed enough to be classed as a technical text-book.

*An English Holiday with Car and Camera.* By James John Hissey. Pp. xviii+426; with 28 full-page illustrations and a map of the route. (London: Macmillan and Co., Ltd., 1908.) Price 10*s*. net.

It was scarcely necessary for Mr. Hissey to tell us, as he does in his preface, that he travels purely for pleasure and "in search of the picturesque." Those readers who know the author's many pleasant, gossipy books about English by-ways have long been aware, from the optimistic way in which rural England is described, that Mr. Hissey loves exploring his native land. This time the journey taken by the author and his wife was confined to motoring in the country south of a line joining the Wash to the Bristol Channel. The account of the wanderings, with its many glimpses of the home-life of the country people, and the excellent illustrations, combine to make a very interesting volume.

*Pearls and Parasites.* By A. E. Shipley, F.R.S. Pp. xv+232; with illustrations. (London: John Murray, 1908.) Price 7*s*. 6*d*. net.

The title of Mr. Shipley's book scarcely serves to indicate the general character of the contents. The volume contains nine essays, which, with one exception, deal with problems of economic zoology. The subjects introduced vary considerably among themselves, as the following titles show:—Pearls and Parasites; the Depths of the Sea; British Sea-fisheries; Zebras, Horses, and Hybrids; Pasteur; Malaria; "Infinite Torment of Flies"; and the Danger of Flies. The concluding essay is an inquiry into the aims and finance of Cambridge University. Most of the essays have appeared previously in periodicals, and have been read by many people interested in science. The subjects discussed are sufficiently important to attract the scientific as well as the general reader.

*Architectural Education.* By Wilfrid I. Travers. Pp. vii+119. (London: Harrison, Jehring and Co., 1908.) Price 4*s*. net.

The subtitle of this book indicates its character with fair precision; it runs:—"A history of the past and some criticisms of the present system, upon which are founded some suggestions for the future, with particular reference to the position of the universities." Mr. Travers has collected much information as to the courses of training for architects and the syllabuses of the examinations conducted by the Royal Institute of British Architects and many universities, and also offers useful suggestions for their improvement. Many of the schemes of work here tabulated appear to give little prominence to the training in the principles of science which are necessary for an architect to ensure successful work.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### A Suggested Explanation of the High Velocities of Gases observed on the Solar Surface.

The important discovery by Prof. Hale of the Zeeman effect in sun-spot spectra proves the presence of extensive areas on the solar surface in which ions of one kind largely preponderate. This suggests the solution of one great difficulty which has blocked the way in the attempts that have been made to explain the very high velocities which are not unfrequently observed near the solar surface by spectroscopic and other means. For there is a limit to the velocity of a gas impelled by pressure only, this being the velocity with which it streams from a high pressure into a vacuum, and we may put this limiting velocity to be equal to that of propagation of sound in the gas. Observation shows that the highest velocities observed on the solar surface are about 200 times as great as the velocity of sound in hydrogen at the temperature of freezing water.

If, then, these masses of moving matter are impelled by pressure only, the number expressing their absolute temperature divided by the density must be 40,000 times greater than the corresponding number in the case of hydrogen at 0° C. Taking the absolute temperature of the sun to be forty times as great as that of freezing water (which cannot be far from the truth), the observed velocities would become consistent with our supposition of pressure-motion only if the density of the gas were a thousand times less than that of hydrogen. This brings us down to the mass of the negative electron. As, however, spectroscopic evidence indicates the motion of ponderable matter (principally, if not solely, composed of hydrogen), we must assume that gases are entangled in the rush of electrons, but not to a sufficient degree to alter the average density materially. In the case of matter in which one kind of electrons preponderate, electric forces may, of course, increase the velocities almost to any extent, but the close agreement of the observed high velocities with the limiting velocity in a gas, having a density equal to the thousandth part of that of hydrogen, and being at a temperature agreeing, so far as we can tell, with that of the solar surface, is highly suggestive. I conclude, therefore, that if the observed velocities are real—and there is good ground for believing them to be so—the prominences and other appearances in which velocities of more than about 10 kilometres a second are observed are composed to a preponderating extent of electrons in which gases are entangled to a sufficient degree to give the spectroscopic test, but not sufficiently to alter materially the average density.

In conclusion, I should like to urge a word of caution with respect to the last paragraph of Prof. Zeeman's article on Prof. Hale's discovery. The magnetic forces indicated by the splitting up of the lines are not sufficient to produce any direct observable magnetic effect at the distance of the earth. ARTHUR SCHUSTER.

Simla, October 6.

### The Magnetic Disturbances of September 29 and Aurora Borealis.

SOME details of an unusually bright aurora, seen at Omaha, U.S.A., on the night of September 28, local time, may be of interest to the readers of NATURE in connection with the three-hour magnetic disturbance recorded on our magnetograms between 4 a.m. and 7 a.m. of September 29, Greenwich time.

The details come from Father Rigge, S.J., director of the Creighton University Observatory, Omaha. The sky was perfectly clear throughout the night. The aurora "seemed to commence suddenly at 9.50 p.m.," September 28, local time, *i.e.* at 4.15 a.m., September 29, Greenwich time, when the unifilar magnet at Stonyhurst commenced a rapid westward movement up to 62′ of arc at 4.40 a.m., returning more slowly in three sudden steps backward at 5.5 a.m., 5.35 a.m., and 6 a.m., accompanied by minor rapid oscillations.

The aurora was watched for two hours, up to the local midnight, and during this time alternations of the scene were observed between brilliant streamers of various lengths and breadths from a well-defined arch, and a broken-up arch accompanied by drifting luminous patches as of fiery clouds. It would have been interesting to compare the times of these changes with the halting movements of the magnetic needle, but the time was recorded only of the first appearance of the *streamers,* the smaller lengths of which "seemed to come directly out of the ground," and the noted time agrees closely with that of a single break in the first long and rapid deflection of the needle—a short step-back followed by a rush forward to its greatest elongation. The aurora was again looked for at 5 a.m. of the following morning, when nothing was seen in the still unclouded sky.

It is therefore probable that the auroral display began and ended synchronously with this greater deflection of the needle.

The three-hour wave was, then, followed by the usual rapid oscillations consequent upon a magnetic storm until 2.50 p.m., September 29, G.M.T., when another and a greater storm broke out and lasted until 4.30 of the following morning. At Omaha aurora was again seen at 7.15 p.m., September 29, local time, but in a less favourable sky, which clouded over at 9.15, and showed only by the brightened clouds that the aurora was still active at 10 p.m., when the greater oscillations of the magnets were ending. WALTER SIDGREAVES, S.J.

Stonyhurst College Observatory, October 21.

### A Method of Solving Algebraic Equations.

So far as I can ascertain, the method referred to is not known, at least in its complete form. It is a development of a method described by me in a previous paper ("Verb Functions, with Notes on the Solution of Equations by Operative Division," Proceedings of the Royal Irish Academy, vol. xxv., Sec. A, No. 3, April, 1905), which was reviewed in NATURE of April 25, 1905. I give it here as briefly as possible.

Take, for example, the equation used by Newton to illustrate his method of approximation, namely,

$$x^3-2x-5=0,$$

which has one real root, 2·09455. . . . Write the equation in the form $x^3=2x+5$. Select any real number, $x_1$; substitute it for $x$ in the right-hand member of the equation, and then find $x_2$ from $x_2=\sqrt[3]{2x_1+5}$. Next substitute $x_2$ for $x_1$ in the right-hand side of the equation, and find the value of $x_3$, and so on. We thus have a series of numbers connected by the equation $x^3_{n+1}=2x_n+5$, and it will be found that whatever number we start with for $x_1$, $x_n$ constantly approaches the value of the root. Thus, if we begin with 11, we have $x_1=11$, $x_2=3$, $x_3=2·2240$, $x_4=2·1140$, $x_5=2·0975$, $x_6=2·0940$, . . . . Or, commencing with $-100$, we obtain $x_1=-100$, $x_2=-5·7989$, $x_3=-1·8756$, $x_4=1·0768$, $x_5=1·9268$, $x_6=2·0688$, $x_7=2·0907$, $x_8=2·0940$, ...

Again, take the equation $x^3-15x-4=0$, which has three real roots, 4 and $-2\pm\sqrt{3}$, that is, 4, $-0·2678$, and $-3·7321$. Write it in the form $x^3=15x+4$, and begin with any number above the limits of the positive roots, say 16. Substitute this for $x$ in the right side of the equation, and proceed as before. Then $x_1=16$, $x_2=6·2488$, $x_3=4·6062$, $x_4=4·0124$, $x_5=4·0039$, . . . ., which is nearly the first root.

In order to obtain the next lower root take for $x_1$ a number which is a little less than the first root, say 3·9, and substitute it for $x$, *not* in the *right* side of the equation, but in the *left* side, so that now $\dfrac{x_1^3-4}{15}=x_2$. Thus we obtain $x_1=3·9$, $x_2=3·6880$, $x_3=3·0558$, $x_4=1·6356$, $x_5=0·0351$, $x_6=-0·2666$, $x_7=-0·2679$, . . . ., which is nearly the second root.

For the third root take a number, say $-0·3$, which is a little less (algebraically) than the second root, and substitute it for $x$ in the *right* side of the equation, as done for the first root. We thus obtain $x_1=-0·3$, $x_2=-0·7937$, $x_3=-2·0$, $x_4=-2·9625$, $x_5=-3·4313$, $x_6=-3·6203$, $x_7=-3·6910$, $x_8=-3·7169$, $x_9=-3·7267$, . . . ., which is nearly the third root.

We can solve the equation in the same manner by beginning with any number, say $-5$, which is below the limit of the negative roots, and substituting it for $x$ in the right side of the equation; then after finding the lowest root, substitute a greater number for it in the left side of the equation, and so on. We may thus either descend from the highest to the lowest root, or ascend from the lowest to the highest. It is evident that a root is obtained when $x_{n+1}=x_n$, because the equation is then satisfied.

We took the original equations in the forms $x^3=2x+5$ and $x^3=15x+4$, but we may take them also in the forms $x^2=2+5/x$ and $x^2=15+4/x$, or in other forms obtained by ordinary algebraic or operative transformations; and the method of solution is the same.

The rule is most easily explained geometrically. Let $f(x)=0$ be the original equation. Write it in the form $f_2(x)=f_1(x)$, as may usually be done in many ways. Draw the curves $f_2(x)=y$ and $f_1(x)=y$. Then the roots of $f_2(x)=f_1(x)$ are evidently the abscissæ of the points of intersection of the two curves. The procedure adopted above is really as follows. Select any point, $x_1$, on the axis of $x$, and draw a straight line from it parallel to the axis of $y$, either in the positive or in the negative direction, until it meets the *nearer* of the two curves—let us say $f_1(x)=y$. From this second point draw a line parallel to $y$ until it meets $f_2(x)=y$. From the third point draw a line parallel to $x$ until it meets $f_1(x)=y$ again, and from the fourth point one parallel to $y$ until it meets $f_2(x)=y$ again, and so on. Then the abscissa of the first and second points is $x_1$, of the third and fourth points is $x_2$, of the fifth and sixth points is $x_3$, and so on, and $x_n$ must generally approach nearer and nearer to the point of intersection of the two curves—that is, to a root of the original equation.

Fig. 1 represents an intersection where the lines drawn according to the rule all lie within the angles formed by the converging curves. In this case, analytically, $x_1$, $x_2$, $x_3$, . . . ., are all either greater or all less than $x$, the abscissa of the point of intersection, although they constantly approach it. Fig. 2 illustrates the case where the lines ultimately approach the intersection spirally. Here, analytically, $x_1$, $x_2$, $x_3$ . . . alternately oscillate above and below $x$, although they constantly approach it. The former, or "staircase" procession, occurs while the differential coefficients of the two curves have the same sign: the latter, or alternating "spiral" procession, while they are of opposite signs.

The staircase procession trends in the same direction as the tangent vectors of the curves if $x_2-x_1$ is positive, and in the opposite direction if $x_2-x_1$ is negative. A similar law holds for the direction of rotation of the spiral procession. Thus $x_1$, $x_2$, $x_3$ . . . will increase or decrease, either continuously or alternately, according to whether we have taken $x_1$ on one or the other of the two curves

$f_2(x)=y$ and $f_1(x)=y$. If we have taken it on the wrong curve they will diverge from the required intersection, as will be apparent from Figs. 1 and 2. The rule to ensure ultimate convergency is that at or near the point of intersection $x_1$ shall be taken upon the curve which has the numerically lesser differential coefficient. If, at the point of intersection, the differential coefficients are numerically exactly equal, the method fails, as $x_{n+2}=x_n$; but the intersection of the curves will then be at the intersection of the tangents, so that $x=\frac{1}{2}(x_{n+1}+x_n)$—Fig. 3. It often happens, if we have taken $x_1$ at random, that the succeeding terms of the series are at first irregular, but afterwards converge.

If at any stage in the analytical process a term becomes unreal, this means that the corresponding line drawn from one of the curves cannot intersect any branch of the other curve. We must then start again with another value of $x_1$.

The successive terms may appear to converge for a time and may then diverge. This indicates the position of a pair of imaginary roots (Fig. 4). Compare, for instance, $x^2=13x-42$, of which the roots are 6 and 7, with $x^2=13x-43$, of which the roots are imaginary.

Convergency is slowest when the differential coefficients of the curves at the required intersection are nearly equal, numerically, to each other, especially if both are also nearly equal to $\pm 1$. It is quickest when their numerical difference is greatest. When we have arrived near enough to the destination, further work may often be abbreviated by assuming that the intersection of the curves nearly coincides with that of the tangents. Thus if $x_1$ and $x_2$ are successive convergents on the curves $f_1(x)=y$ and $f_2(x)=y$ respectively, then, approximately,

$$x=\frac{x_1 f_1'(x_1)-x_2 f_2'(x_2)}{f_1'(x_1)-f_2'(x_2)}.$$

In the case of the equation $x^3=15x+4$ the roots were obtained successively by taking $x_1$ alternately, first on one curve, $15x+4=y$, and then on the other, $x^3=y$. This can be done very frequently, but sometimes one of the curves makes such a bend between two intersections that, by the rule already given to ensure convergency, $x_1$ may have to be taken on the same curve for two roots in succession. By plotting the curves roughly on paper it is generally easy to see at a glance how best to commence and conduct the process (Fig. 5).

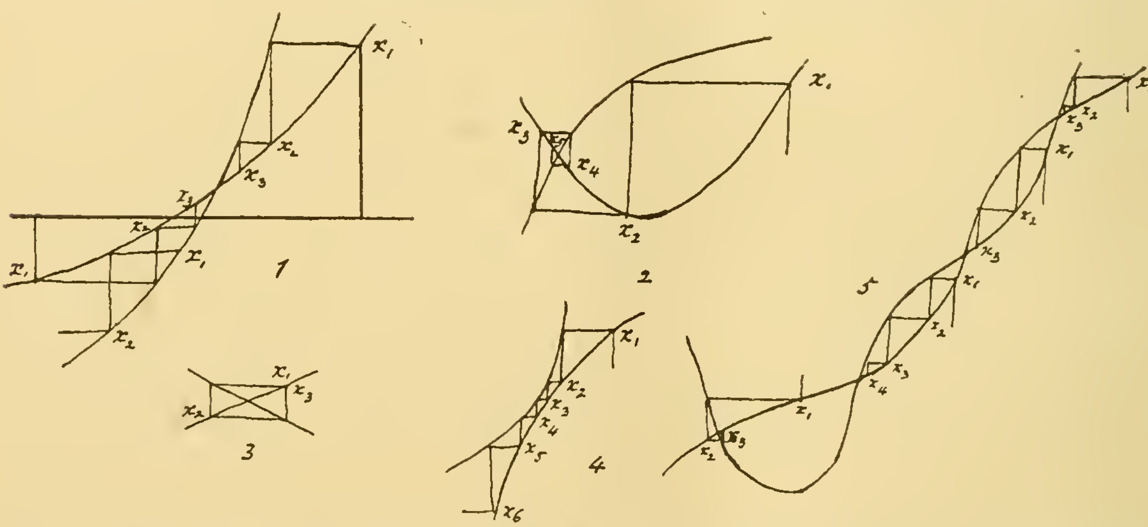
As is evident from the geometrical interpretation, the method is by no means restricted to rational integral equations. The two curves $f_2(x)=y$ and $f_1(x)=y$ may be any we please, provided only that we can obtain $x=f_2^{-1}(y)$, or at least can evaluate it for different values of $y$, and it is generally easy to put the original equation $f(x)=0$ in such a form that this can be done; but in order to find some of the roots it may be necessary to take $x_1$ on the other side of the equation, which requires us also to obtain $x$ from $x=f_1^{-1}(y)$, which may be difficult. Generally, however, this can be avoided by finding special roots from other forms of the equation. For example,

$$x^3-3x^2-2x+5=0$$

has three roots, 3·128, 1·202, and −1·330, but they can be calculated more easily from the form $(x-1)^3=5x-6$. One or two of the roots of a complete rational integral equation may frequently be obtained almost at once by dividing the equation by $x^{-1}$, and putting it in the form $x=a+b/x+c/x^2$. . . . Generally, the first terms of the series $x_1$, $x_2$, $x_3$ . . . may be estimated mentally, exactness being unnecessary until we approach near to a root.

The rule, therefore, has the advantage of being very easily remembered, of giving, theoretically, all the roots in succession, and of leading, almost automatically, to at least one or two solutions. Hitherto it has been considered from the geometric and arithmetic side; I will now try to indicate briefly its operative and algebraic forms.

We have evidently to do with repeated operation, which is best expressed by the algorithm of "verb functions" as described in my paper referred to. This algorithm is based on the fact that $\phi^0$, where the index refers to operative and not algebraic involution, cannot possibly be the equivalent of numerical unity (as generally held), but is equal to *operative unity*. I denote this by the symbol $\beta$ (for base). When substituted for the argument in any expression, $\beta$ converts that expression into one which denotes an action, not a substantive. Thus $a+b\beta+c\beta^2$ is the action performed on $x$ in order to convert it into $a+bx+cx^2$.



1 2 3 4 5

Now let $x^n+ax^{n-1}+bx^{n-1}$ . . . $=k$, the number of terms being unlimited. Then

$$x=[\sqrt[n]{k-a\beta^{n-1}-b\beta^{n-2}\ .\ .\ .}]x,$$

where the square brackets denote that the expression contained within them operates on the following matter, and is not multiplied into it. Thus $x$ on the left side of the equation is the result of an operation performed on itself. Similarly, $x$ on the right side of the equation is the result of the same operation performed on itself as many times as we please. Hence we obtain the identity

$$x=[\sqrt[n]{k-a\beta^{n-1}-b\beta^{n-2}\ .\ .\ .}]^q x,$$

where $q$ denotes operative involution and may be any integer, positive or negative, to infinity. Now the expression on the right can be developed with the aid of the multinomial theorem by successive substitution, according to the common algebra of verb functions, and we obtain

$$x=k^{\frac{1}{n}}-\frac{1}{n}a-\frac{1}{1}\left\{\frac{1}{n}b+\binom{1}{n}^{(2)}\frac{a^2}{2!}\right\}k^{-\frac{1}{n}}-\frac{1}{2}\left\{\frac{2}{n}c+\binom{2}{n}^{(2)}ab+\binom{2}{n}^{(3)}\frac{a^3}{3}\right\}k^{-\frac{2}{n}}\ .\ .\ .$$

+ terms containing $x$.

When this series proceeds to infinity the terms containing $x$, under certain conditions, vanish. So also they vanish if any proximate number is substituted for $x$ in them. We are thus left with $x$, on the left side, equated to a series containing only $k$ and the coefficients $a$, $b$, $c$ . . . . This explains why we may start the process described at the beginning of this paper with *any* number (under certain limitations) for $x_1$, because, whatever that number may be, it is gradually rendered negligible by the successive operations.

The series has been already studied to some extent in the paper referred to, and has been used for solving equations. Its coefficients are simply those of the multinomial theorem with some modifications. As it has $n$ values depending on the $n$ values of $\sqrt[n]{k}$, we may suppose that these values are the $n$ roots of the original equation, though we may not be able yet to evaluate all of them. This has been proved in the previous paper to be the case, because the sums of the products of the values taken one, two, three . . . times together are equal to the successive coefficients of the original equation with the proper signs. Hence there are some reasons for thinking that the series theoretically constitutes the general *transcendental* solution of the equation of the $n$th degree. How far this is really the case must be discussed more fully on another occasion, together with details and developments of the method outlined above.

The method is not the same as the methods of approximation of Newton, Lagrange, and Horner. The well-known ascending power series for the reversion of a function, and cases in which certain repeated operations (such as continued fractions) converge to a root of an equation, thus solving certain functional and difference equations, are only particular instances of the above theorem.

Ronald Ross.

## The Nature of X-Rays.

In a letter to Nature of July 30 Prof. Bragg tries to show that his neutral-pair theory of X-rays may form the basis of an explanation of the secondary X-ray phenomena which I briefly summarised in an earlier letter (May 7). He, however, neglects the consideration of so much important evidence that I cannot attempt to reply in detail. In reply to his discussion of statements (3), (6), and (5), I need only state that he has confused two distinct types of secondary X-radiation, and that his statement of Mr. Crowther's results is inaccurate when applied, as he applies it, to the scattered radiation alone. (May I also be permitted, in passing, to point out that both the general results attributed to Mr. Crowther had been published by the writer previous to the publication of Mr. Crowther's paper?)

Again, Prof. Bragg has evidently overlooked the work to which I referred in statements (7), (8), and (9). The evidence which I put forward for consideration was not the older work of M. Sagnac, Dr. Walter, and Mr. Adams which Prof. Bragg discusses, but the results of experiments by Mr. Sadler and myself on homogeneous beams of X-rays, which have not yet been published in full, though preliminary notices had appeared in Nature. The paper giving an account of this work was read before the London Physical Society on June 12. Prof. Bragg, as a consequence, does not discuss the points with full knowledge of experimental facts.

Of the three remaining points, one—the polarisation of a *primary* beam (1)—is not discussed, because Prof. Haga has been unable to verify it by a much cruder method than that originally employed. It is nevertheless a physical fact.

Finally, two results—the polarisation in scattered radiation (4) and the equality in the penetrating powers of primary and secondary (scattered) rays (2)—which appear possible to Prof. Bragg on the neutral-pair theory, require assumptions which, to my mind, are extremely doubtful. On the other hand, many of these results were foretold on the ether pulse theory, and, indeed, they all find an easy explanation on this theory, as I believe Prof. Bragg will readily admit when he has become fully acquainted with the experiments. For a fuller discussion I can, unfortunately, only refer to two unpublished papers, both of which, however, are in the press. These are the one already referred to and one which will appear in the forthcoming number of the "Jahrbuch der Radioaktivität und Elektronik."

In reply to Prof. Bragg's contention, may I add that the phenomena involving radiation of only one kind—X-radiation—to me appeared simpler than those involving two—X and $\beta$ radiations?

Liverpool, August 8. Charles G. Barkla.

It is, of course, true that my letter (dated June 5) to which Dr. Barkla refers was written before I had had the opportunity of studying Dr. Barkla's latest results. A portion of my argument was based on his earlier work, and may need a little alteration in consequence. I have myself found by recent experiment that his older statements needed amendment. For example, the emergence and incidence secondary Röntgen radiations differ both in quality and quantity; the former is sometimes far greater than the latter.

May I take this opportunity of correcting a statement in a letter of mine which appeared in Nature of July 23? As pointed out in an addendum to a recent paper contributed by Dr. Laub to the *Annalen der Physik*, I have been wrong in supposing that Dr. Wien still maintains that the energy of the secondary kathode ray is drawn from the energy of the atom. Had I understood Dr. Wien correctly, I should certainly not have taken so much pains to disprove a theory which he had already abandoned.

W. H. Bragg.

The University of Adelaide, September 17.

## The Supposed Inheritance of Acquired Characters.

Dr. Francis Darwin, in his presidential address before the British Association, writes as follows:—

"Fischer showed that when chrysalids of *Arctia caja* are subjected to a low temperature a certain number of them produce dark-coloured insects; and further that these moths mated together yield dark-coloured offspring. This has been held to prove somatic inheritance, but Weismann points out that it is explicable by the low temperature having an identical effect on the colour-determinants existing in the wing-rudiments of the pupa, and on the same determinants occurring in the germ-cells."

It occurs to me that still another explanation is possible to cover at least some such cases. In discussing various types of latency, Dr. Shull (*American Naturalist*, July) has recently defined as "latency due to fluctuation" those cases (of which many are known) in which the special characters of a race do not appear except under suitable conditions. Following this idea, it is possible to think of the dark *Arctia caja* appearing after exposure to cold as representing a variation which possessed an inherent tendency to darkness not exhibited under more ordinary conditions. Indeed, this must have been the case, since only "a certain number" were affected. Given such a variation, it is not unreasonable to suppose that when examples were mated together the tendency would be so emphasised as to appear under normal temperatures, thus producing an apparent case of the inheritance of acquired characters.

T. D. A. Cockerell.

University of Colorado, October 7.

## Determination of Sex: a Correction.

May I correct a slip in your report of "Zoology at the British Association" (Nature, October 22, p. 647)? The cinnamon canaries resulting from the mating green hen × cinnamon cock are all *females*, not males, as there accidentally stated. The point is critical in the interpretation of that curious case.

W. Bateson.

October 26.

## DROPS AND SPLASHES.[1]

THE few who have access to the Transactions of the Royal Society, and who remember the first presentation of Prof. Worthington's beautiful photographs illustrating the successive movements that occur in the phenomenon of the splash of a drop, and some proportion of the many who may have seen his two articles on the subject in *Pearson's Magazine*, will welcome the appearance of the fascinating quarto volume entitled "A Study of Splashes." Not only will their recollection of an interesting research be revived, but the more perfectly executed and more numerous and complete series of photographs here presented will show the phenomena in all their original beauty as displayed on the lantern screens at the Royal Institution and elsewhere.

Besides showing the results and explaining the interesting cooperation of the forces of dynamics and of surface tension which have given rise to the phenomena, Prof. Worthington has given very full details of his method so that many who can extemporise physical apparatus will be able to follow him, and so to investigate the same or analogous movements.

As a series of twelve or twenty successive photographs illustrating the movements of the liquid which occur in a small fraction of a second cannot at present be taken from a single falling drop or splash, but each requires a new drop to be photographed at a different stage, predetermined in time within one or two thousands of a second, it is essential that so far as is possible the phenomena should be exactly repeated, and that the initial conditions should be identical. The method by which liquid is allowed to drop or balls to fall with sufficient exactness is illustrated and described, and to this no further reference need be made in the present notice. The more interesting part of the apparatus is that in which, the ball or drop having been liberated, an illuminating electric spark is formed as many thousandths of a second after the first contact of the splash as may have been determined, as also is the means of utilising the light of the spark for the purpose of obtaining a shaded picture. This is illustrated on p. 7. The action depends upon the equality of speed of two falling bodies, one the drop or ball which will make the splash, and the other a conducting ball which in its fall will pass close to two nobs forming part of an electric circuit. This circuit comprises the two Leyden jars of an electric influence machine, the nobs in question and the illuminating spark gap, the two nobs being connected with the charged insides, and the terminals of the illuminating spark-gap with the uncharged outsides of the jars. The conducting ball as it passes close to the nobs discharges the circuit, and a spark is formed at the illuminating spark-gap. According as an electromagnetic trigger which liberates the conducting ball is set higher or lower, the time which will elapse after the breaking of the magnetic circuit up to the time of the formation of the spark may be made greater or less at will. The drop or ball which makes the splash is liberated in a similar manner, and so it is merely necessary to increase the height of fall of the conducting ball little by little as compared with that of the drop or splashing ball to illuminate the splash at any desired period of its existence; perhaps not merely necessary, as it is also important that the jars should be charged every time to the same potential, otherwise the spark would not be liberated when the conducting ball had in successive falls reached the same place. The spark is in the focus of an illuminating reflector which gives a large field of light as well as a central bright point, and an ordinary camera with a lens to throw an image of the splash upon the plate completes the means by which the phenomenon which exists at the moment of the spark is photographed with all the perfection of light and shade which make the results so beautiful.

Even with all these precautions successive drops are not necessarily exactly alike at their initiation, as very small changes in the electrical conditions of the two circuits and in the form of a liquid drop, if that is used, at its start will make initial differences which the instability of the liquid forms subsequently developed rapidly accentuate. Still, even with these differences in detail the essential characteristics of a series of drops at different stages are, with the precautions mentioned, so nearly identical that the curiously different characters of splashes made in different circumstances can be well followed throughout their existence.

When the under-water phenomena are photographed the field reflector mentioned above is replaced by a lantern condenser, close to which a fine ground sheet of glass is placed so as to give a uniform field of illumination.

It may be interesting to mention that with the apparatus used by Prof. Worthington he was able to obtain sparks the effective duration of which was not more than three millionths (3/1,000,000) of a second. When it is remembered with what extreme rapidity the edge of a liquid film changes its form under capillary forces, it will be seen that a spark of very short duration is essential, and judging by results one sufficiently short has been obtained.

The book is illustrated by eighteen series of photographs, each series representing a succession of events in one type of splash equivalent as nearly as possible to a succession of events in a single splash. The first series is represented by twenty-four successive photographs of a drop of water falling through a space of 40 centimetres into still milk and water, and there is an alternative smaller series. The second shows the fall of water into water, and incidentally the importance of keeping the water into which the drop falls perfectly free from contamination. Two corresponding photographs are shown side by side; in one the water had been skimmed to purify it from the small trace of grease and smoke which the previous falling drop had brought down from the smoked spoon in which it had been supported; in the other the surface was completely renewed by keeping up a gentle supply of pure water so that contamination could be completely removed by gentle overflow. The absence of a multitude of fine ripples in the first contrasts with the closely furrowed surface of the second, as does a patch on the sea into which a sardine tin has been emptied of its oil with the surrounding portions on a day when the surface is black with small ripples.

Succeeding series show the formation of bubbles, the contrast in the splashes formed by smooth and rough spheres, and other phenomena which it is difficult to describe adequately in a notice and without the photographs to refer to. Some of these are illuminated from above only, and some are illuminated by light on a level with the liquid surface, a transparent cell being used in this case so that the under-water phenomena may be seen as well as those above the surface.

The last series illustrates the effect of the fall of a

[1] "A Study of Splashes." By Prof. A. M. Worthington, C.B., F.R.S. Pp. xii+129; illustrated. (London: Longmans, Green and Co., 1908.) Price 6s. 6d. net.

rough sphere into water from a height of 140 centimetres. Figs. 1, 2, 3, 4, and 5 here reproduced are from this series, and they serve well to show the beauty of Prof. Worthington's results, as also the curious formation of a liquid jet within the temporary bubble.

Figs. 1 and 2 show the open cup with the vertically projected cylindrical sheet of water and its breaking edge. In Fig. 3 the capillary tension has pulled in the sides, and is on the point of completing the bubble. In Fig. 4 the surface of the bubble is being pulled down by the descent of the ball, which reduces the pressure within the bubble. As there is less mass in the film above than in the continuous liquid sides, the roof is at first drawn downwards. At this stage it also thickens from an influx of liquid from the sides, or appears to do so, and this influx, meeting in the centre, gives rise to a powerful descending jet seen in Figs. 5 to 11 of the book. The acceleration is greater than that due to gravity, and it appears that the curved path of the inrushing liquid concave downwards enables it to balance the excess of atmospheric pressure above the bubble.

Fig. 1.—0·006s.

Fig. 2.—0·008s.

Fig. 3.—0·015s.

Fig. 4.—0·021s.

Fig. 5.—0·057s.

Rough sphere falling 140 cm. into water. From "A Study of Splashes."

It would be interesting to see a number of photographs of drops falling into water in conditions often realised unintentionally when a leaking tap allowing drops to fall into a vessel full of water is nevertheless so disposed that either succeeding drops are not almost exactly alike or the water into which the drops fall has not come perfectly to rest so that a musical note is sounded at each fall, the variations in the tone being surprisingly large and erratic. A record of the note, if it could be kept audible by acoustically screening off the snap of the spark, and a comparison of this with the alternating periods revealed by the photographs, should, if it were worth while, make clear the source of the musical note and the cause of its variation.

It is not possible in the space available to illustrate or describe more of the results shown in Prof. Worthington's interesting book. It is hoped that enough has been said to excite the interest of experimentalists and others, who will be well repaid by a study of the original, which should find a place in every scientific library.

C. V. Boys.

## PROGRESS IN AVIATION.

APART from the unsuitability of the epithet, such an incident as is suggested by a recent *Daily Mail* poster, "Aëroplane Triumph; Expresses Collide; Passengers Injured," may not occur for some years to come, but the rapid development of aëroplane locomotion within the last year indicates that it may be desirable, at no distant date, to formulate "rules of the road" for aëroplanes crossing each other's path at the same level, and, unless this is done fairly soon, there may be the same difficulty in obtaining international uniformity that has always existed in such other connections as those of language, coinage, and measurement of time.

The records which have been published from day to day in the Press have now, for the first time, placed the problem of flight on a perfectly practical basis, and a great deal that has been written previously to the present year will only be read with interest now insomuch as it enables a comparison to be made between anticipation and realisation. We heard reports of the Wright Brothers' achievements in America in 1904 and 1905, but owing to the inventors' efforts to avoid publicity the feat of Santos Dumont on November 12, 1906, in covering 220 metres in 21·2 seconds has been regarded by many people as the first realisation of an artificially propelled man-carrying machine lifting itself from the ground and performing an actual flight.

M. Delagrange's aëroplane made flights of 164 feet and 196 feet in April, 1907, and by this time the construction of aëroplane machines began to be taken up from the commercial point of view by several firms in France. The present writer visited Captain Ferber in July of that year, and was shown a large building on the outskirts of Paris specially fitted up with the view of manufacturing aëroplanes to order, one being in process of construction. All previous authenticated records were eclipsed by Mr. Farman's flights in November of last year. Yet these records seem small by comparison with recent French achievements. In these, M. Delagrange figures prominently, as is shown by the following examples, selected without any claims to completeness:—March 21, Farman, 4·5 km. in 3m. 29s.; April 11, Delagrange (Archdeacon Cup), 3·925 km. in 6m. 30s.; June 22, at Milan, Delagrange, 15 km. in 16m. 30s.; June 23, at Rome, Delagrange, 17·5 km. in $18\frac{1}{2}$m., touching ground once; July 6, Farman (Armengaud Prize), 20·4 km. in 20m. 20s.; September 6, Delagrange, 29m. 53·8s.

The Wright Brothers' performances take us a long way back, and include the following statements of flights: September, 1905,[1] 17·961 km. in 18m. 9s., 19·570 km. in 19m. 55s.; October, 1905, 24·535 km. in 25m. 5s., 33·456 km. in 33m. 17s., 38·956 km. in 38m. 3s., the causes of stopping being exhaustion of fuel or hot bearings; May, 1908,[2] flights from 22s. up to 7m. 20s., with one man, distance 5 miles, two-man flights,[3] 0·45 mile in 29s., and 2·5 miles in 3m. 40s.; September 6, 1908, at Paris (Wilbur Wright), flight of 19m. 48s., and in America, September 12 (Orville Wright), flight of 74m. 20s. (these last on the authority of the daily Press).

The first "two-man" flight (in Europe, at any rate) would appear to date from March 21, when, after the flight recorded above, Mr. Farman mounted with M. Delagrange on the latter's aërodrome, which flew a considerable distance with the heavy load.[4] This record, it will be observed, is earlier than the Wright records above chronicled. On May 30 Mr. Farman flew 1·241 km., with Mr. Archdeacon as a passenger, on his aëroplane.[1] Finally, we have a flight of more than $1\frac{1}{2}$ hours by Mr. Wilbur Wright in France, shortly after the accident to his brother's machine in America, through which Lieut. Selfridge lost his life.

Simultaneously with these aëroplane experiments we have a series of chronicles of successes with the Zeppelin and other airships. We need only refer to the Zeppelin record of 11h. 50m., and a record by Major Gross of 13h. 2m., covering a distance of 187 miles.

A very interesting summary of progress in aviation up to the day of publication is afforded by M. Armengaud, junior's, book.[2] It is based on a lecture delivered on February 16 at the Conservatoire des Arts et Métiers, and it contains, in addition to an account of recent work, references to the early researches of Penaud, Marey, and others on flight of birds. A feature of special interest is the diagram showing the various systems of aëroplanes used by different experimenters. The illustration accompanying this article is based on the diagram in question, but we have omitted the purely gliding machines of Wright and Archdeacon, and have inserted the Farman "flying fish" type, as well as a figure of the mechanically-propelled Wright model based on the sketch in the *Scientific American*.

On looking at this table the typical Englishman whose education on current topics does not extend beyond the level of the halfpenny paper will ask, "Which is the best flying machine?" As the interrogator usually is under the prevalent delusion that "a straightforward answer to a straightforward question" is all that is necessary to settle, once and for all, the most complex problem of science, and as he probably will forget all that has been told him when he reads about the next football match, the best way of satisfying him is to give a definite answer by choosing one at random from this diagram and saying it is the best. A general discussion of the different types of flying machine, including, not only aëroplanes, but orthopters and helicopters, is given by M. Armengaud, and this probably contains as much as could be embodied in a small handbook. But a complete examination of the conditions required to give the best results involves the discussion of at least two qualities, efficiency and stability, and while engineers have shown themselves fully competent to deal with the first of these qualities, a full discussion of the latter still involves the expenditure of a large number of brain-power hours of work at the hands of a really competent mathematician, and it will be one of the objects of this note to direct attention to some of the most important unanswered questions involved in the theory sketched out some years ago by the present writer, with the assistance of Mr. Williams.

Captain Paul Renard's two papers on dirigibles[3] may at this stage be studied with advantage. The first paper is mainly theoretical, the second descriptive.

Taking the second part first, it contains an illustrated description of all the principal dirigibles that have been constructed, and of a number that have been projected. Captain Renard expresses the opinion that France, which has produced a Montgolfier and a

[1] *American Magazine of Aëronautics*, July, 1907.
[2] *American Aëronautics*, June, 1908, quoted in *Aëronautics*, supplement to *Knowledge*.
[3] Photographs are given in the *Scientific American* for May 30, 1908.
[4] *Aëronautics* (*Knowledge*), April, 1908.

[1] *Ibid.*
[2] "Le Problème de l'Aviation, sa Solution par l'Aéroplane" (Paris: Ch. Delagrave.) Price 2.50 francs.
[3] "Les Aérostats dirigeables" (*Revue generale des Sciences*, June 15 and 30, 1908).

Col. Renard (whose early experiences with *La France* were greatly in advance of their time), is still to the forefront in aërial navigation by means of airships. He considers, further, that in spite of its interesting details of construction, the Zeppelin aërostat is not to be regarded as a model to be copied. These views we quote, without comment, on the authority of their exponent. The first or theoretical part contains a simple exposition of the elementary principles on which the success or failure of directed aërostats depends. In the first place, the relative velocity of propulsion (*vitesse propre*) must exceed the velocity of the wind if the aërostat is to be completely under control, otherwise the course will be confined within a limited angle. This fact every student of elementary mechanics ought to realise at a glance, but many who succeed in passing examinations fail to do so, and thus Captain Renard's remarks are not so superfluous as they might seem to be to a person who really understood elementary mathematics. As the present writer pointed out, it is mainly the difference in speed between air currents and ocean currents which has rendered aërial navigation less successful hitherto than ocean navigation.[1]

Captain Renard discusses the questions of permanence of form and the relative advantages of large and small screws, and then proceeds to the question of stability. He distinguishes three different kinds of stability, namely, stability in altitude, stability of course, and longitudinal stability. According to the conditions assumed in text-books, when a balloon is in equilibrium at any altitude that equilibrium is stable, so that "instability in altitude" is not a mechanical effect, but consists in the effects of physical causes in disturbing the vertical equilibrium of a balloon; in a dirigible there are many easy methods of maintaining a constant altitude. Instability of course or instability in a horizontal plane occurs when an aërostat tends to turn about a vertical axis so as to set itself at right angles to the direction of motion, like the ellipsoids of our text-books in hydrodynamics. In longitudinal instability the aërostat tends to turn about a horizontal axis, pitching over forwards or backwards. Captain Renard points out (and this is entirely in accordance with the present writer's investigations) that there is a certain limiting or *critical* velocity consistent with stability; in the case of the dirigible the critical velocity is a superior limit, which cannot be exceeded without the motion becoming unstable. He also clearly shows that this fact was known to Col. Renard in 1904, and further that the critical velocity in question in many types of machine, such as the *La France*, *Lebaudy*, and *Patrie*, has fallen considerably below the maximum speed obtainable from suitable motors. For example, "In the *Santos Dumont* the critical velocity is 8·50 m. (per sec.), and a 7 horse-power engine is sufficient to obtain it; if longitudinal stability were assured, the aërostat could be provided with a 22-horse-power engine and attain a speed of 12·10 m. For the *Lebaudy* the critical velocity is 10·80 m. requiring 41 horse-power. If this aërostat were stable it could carry a machine of 95 horse-power, which would give it a proper velocity of 14·20 m."

Yet we find another writer attempting to compare the stability of the *Patrie* and *Zeppelin* in a paper bristling with unnecessary mathematical formulæ, which do not even correctly represent the oscillations of the balloons about a statical state of equilibrium.[2] All that the calculation really does is to treat the balloons as simple pendulums the points of support of which are at the centres of buoyancy, and the masses of which are concentrated in the cars. The use of the word "moment of inertia" tends to conceal the fact that the moment of inertia of the framework about its centre of gravity is completely ignored.

Passing on to the equilibrium and stability of aëroplane systems, we find that not only is there a widespread neglect of even some of the most elementary mathematical principles underlying the subject, but the experimental evidence commonly accessible is insufficient to enable any very definite conclusions to be drawn as to the best form of a flying-machine or as to how far the types which have admittedly given successful results are capable of improvement. The lift and drift of aëroplanes have been carefully measured, and so far as the problem of flight depends on their numerical magnitudes, the theory of the aëroplane is summed up "in a nutshell" on pp. 40, 41 of M. Armengaud's paper.

In the construction of motors the main, if not the only, object to be aimed at is to make the weight as small as possible for a given horse-power, a problem with which engineers have shown themselves sufficiently competent to deal. The best system of aëroplanes from the point of view of general efficiency is that which requires the least horse-power to sustain a given total load in horizontal flight. The actual arrangement of the planes will not affect the efficiency except when one plane is placed in the wake of another. But in connection with equilibrium and stability the conditions are very complex, and a great deal of difficult mathematics is required.

Take the question of propellers. The present critic makes no claim to have examined the literature that has collected around this problem in connection with its more or less closely allied applications to naval architecture, but it is certain that what has been found out regarding the efficiency of a ship's screw should form a starting point for discussions relating to airship propellers, account being taken of necessary modifications. Yet the most crude methods are forming the subject of published papers at the present time. C. M. Woodward's problems[1] would make suitable examples for a conventional text-book on "Dogmatics" (as dynamics should be called) if their working were correct, but the expression for the rate of working in driving an airship "thru" the air involves an error closely resembling that made when the oar is treated as a lever of the second class. The succeeding results regarding the horse-power applied to the "scru" would therefore be incorrect even if the fundamental assumptions were justified. W. B. Parsons[2] deals mainly with experiments, but it may be reasonably doubted whether he has really kept the *power* of his motor constant when the inclination of his blades has been varied. To do so the torque would have to be inversely proportional to the angular velocity. Neither the stated method of regulating the power nor the statement "The consequent variation in velocity is the expression of the air resistance for that inclination and velocity" (whatever this may mean?) appear reconcilable with this assumption.

But to come to the important question of stability, of which longitudinal stability, being the most important, shall alone be considered here. A large proportion of the contributors to aëronautical journals have the vaguest possible ideas as to what stability means. The successful flights of Farman, Delagrange, and Wright do not enable us to infer without further evidence that their machines are automatically stable. The analogous problem of the bicycle illustrates this fact. The lateral stability of the bicycle, like the

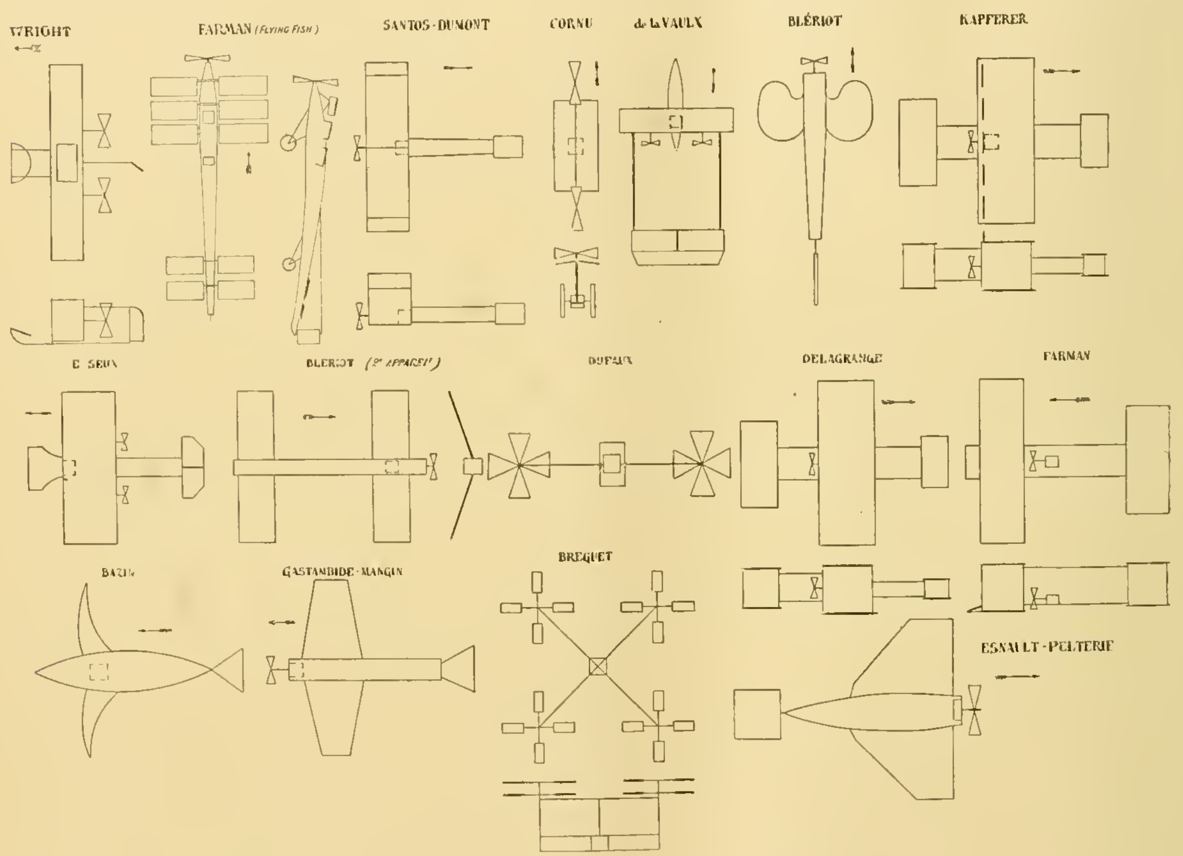
[1] *Cornhill Magazine*, May, 1907.
[2] Capt. Guido Castagneris in the *Aëronautical Journal* for July, 1908.

[1] "Airship Propeller Pr blems," Trans. Acad. Sci., St. Louis, xviii., No. 1.
[2] *Aëronautical Journal*, April, 1908.

longitudinal stability of the aërostat or aëroplane, depends, we believe, on the roots of a biquadratic equation, but in this case there appear to be two critical velocities, one an inferior and the other a superior limit to the speed. Of these the superior limit has been reached in bicycling in the wake of an express train. But bicycles are frequently ridden at speeds below the inferior limit, being kept upright by careful balancing involving no *conscious* effort on the part of the rider. It is highly probable that in many circumstances longitudinal instability may be equally well counteracted by the unconscious efforts of the aviator. Regarding the recent successes, evidence is far too conflicting to enable judgment to be passed in this review as to whether the machines were really stable, though there is equally no evidence to show that they were not.

"Now M. Léon Delagrange, after making quite a number of short flights (the longest about 200 feet) with his motor flying-machine, has found it advisable to go with M. Voisin, the cleverest of the French flying-machine pilots, to experiment with a gliding machine on the sand-hills near Le Touquet." [1]

However probable it may be that a man-carrying machine is automatically stable, the performance of a successful directed flight can never definitely answer the question how far the success is due to automatic stability and how far to the skill of the operator. It may be that with a little experience something short of truly automatic stability is sufficient for all practical purposes; on the other hand, a great many writers who place their views before the public insist on automatic stability as a *sine quâ non*. The evidence derived from uncontrolled aërodromes such as those




Plans of the principal Aëroplanes. From "Le Problème de l'Aviation," with slight modification.

Chanute long ago experimented on automatic stability, and stated that his gliding machines had special appliances for securing it.[1] It is scarcely possible that Chanute's methods have not been utilised by the Wrights. Yet according to the papers the French aviators, while expressing great admiration for the Wright performances, are of opinion that the successful balancing of the Wright machine is mainly a feat of skill on the part of the aviator, and that their object has been to construct machines with which anyone can fly. In support of this view we read that "neither M. Delagrange nor Mr. Farman had ever driven an aëroplane before the last eight months." [2] On the other hand, we were told more than a year ago that

[1] See, *e.g.*, *Cassier's Magazine*, June, 1901.
[2] *Aëronautics*, August, 1908, p. 61.

used by Langley enables the question of automatic stability to be tested much more definitely. The recent reprint of Langley's researches will always prove a valuable contribution to the literature of aviation.[2] But in employing results of experiments with small models to draw conclusions about larger machines, everything depends on a correct appreciation of the theory of dimensions, and who is there that is sufficient of a mathematician that he can be absolutely trusted not to drop into one of the innumerable pitfalls that beset this elusive but valuable method of generalisation?

Even to make a machine fly steadily in a horizontal

[1] *American Magazine of Aëronautics*, July, 1907, p. 8.
[2] "Researches and Experiments in Aërial Navigation." By S. P. Langley. Reprinted from the Smithsonian Reports. (Washington: Government Printing Office, 1908.)

line at all, three conditions are required. It is not sufficient that the drift should equal the thrust of the propeller (supposed horizontal), and that the lift should equal the weight. There is the third condition that the three forces, weight, propeller thrust, and resultant air resistance, must pass through one point, or an equivalent condition obtained by equating moments. If this condition is satisfied, but not otherwise, the machine is properly *balanced*, and may fly straight. But its flight is not necessarily *stable*, and it may upset at any moment. To find if it is longitudinally stable we must examine what happens if it deviates from its course and begins to pitch. To specify its motion at any instant in this case *three* variables are required, as every student of elementary mechanics ought to know. The resultant air resistance will also be altered, and to specify the new resultant three other variables will be required. The connection between these and the preceding three depends on the laws of aërial resistance. This connection is specified by certain "coefficients of stability" the values of which are necessarily based on experimental knowledge. On the assumption that if these are known, and the weight, position of the centre of gravity and moment of inertia of the flying-machine are known, the oscillations have been worked out and the condition of stability determined. This condition is conveniently expressible in terms of a critical velocity, it being necessary for stability that the velocity of a machine flying in a given manner should not be less than the corresponding critical velocity given by theory. In the case of a balloon we have learnt, on the other hand, that the velocity must not be greater than the critical velocity. The existence of a critical velocity was recently pointed out by Mr. Lanchester in a communication to the British Association, and it is to be hoped that his remarks will carry some weight with the preeminently unpractical "practical men" who abound in this country.

When these results were obtained it still remained to reduce the problem of stability to the form of rules which were not beyond the ken of the ordinary working mechanic, and, further, to show how the necessary data could be obtained from experiments on models. Had the present writer been able to give his whole time to this work the problem of stability would have been thrashed out to the bitter end long ago. Looking at the matter perfectly impartially, and in view of many cases of a similar kind that may occur in almost any branch of science, the question may be asked whether it is desirable that the completion of such investigations should be delayed indefinitely because those who are prepared to undertake them are debarred by their professional duties from giving the necessary time? The cost of a mathematician's time in working out such a problem would probably not exceed the cost of building a single flying-machine, so that the existing method of trial and error is certainly not to be recommended on the ground of *cheapness*.

The critical velocity of a machine moving in air depends on the position of its centre of gravity, the moment of inertia of the machine, the form, dimensions, and position of its supporting surfaces and tail, and the position of its propeller. In some cases stability may be increased by increasing the moment of inertia; in other cases it may be decreased. Our work tended to show that a machine might become unstable if the moment of inertia were *either* too large or too small, other things being kept constant. But when the mathematical theory has been worked out in every detail, the coefficients of stability for any given machine must necessarily depend on experimental data. Now the average mechanic understands the importance of finding the resultant thrust on an aeroplane, but he does not realise the necessity of finding the centre of pressure through which this thrust acts. The result is that experimental data are far from complete on the very points in which they are most wanted. If, however, we were to try and base our stability calculations entirely on the experimental data obtained for the separate aëroplanes, we should not only have a good deal of calculation to perform, but at the end we should have omitted to take account of the resistance of the framework, car, and rider. A simpler plan would be to construct a stabilimeter[1] for experimenting on models as a whole instead of with single aëroplanes. When a machine begins to pitch and rock it has a rotatory as well as a translatory motion, and the rotation may, and certainly does, influence the magnitude and position of the resultant thrust of the air. No calculation of stability can be considered valid which does not take account of this influence. One might just as well neglect the wedges of immersion and emersion in working out the stability of ships. On this turning effect, as it might be called, we have no experimental data whatever. But if a model is to be tested in a stabilimeter, the mechanic will require simple working rules for applying his results, and these must in the end be laid down by mathematicians. In particular he will have to be told whether he can improve the stability of his model by altering the positions of his aëroplanes or the moment of inertia of his machine. A number of questions require answering, and the answers require putting in a simple form. Here is one example: In a dirigible the critical velocity represents the greatest velocity consistent with stability; in an aëroplane system it represents the least velocity. If, starting with a dirigible, we add aëroplanes and reduce the size of the balloon gradually down to nothing, we must come across an intermediate type which is either always stable or always unstable. What is this type?

The recent flights show what can be done in aviation by a person possessed of skill and experience. They are a necessary factor in the development of artificial flight. The problem is quite in a different position from what it was a year ago. But if flying-machines are to be made accessible to the million, the sooner English aëronauts learn mathematics or get someone to do the mathematics the better. At the present time a great deal of rubbish passes off as mathematics which is quite unworthy of the name. We may instance the use of Taylor's expansion in infinite series to prove, not even that the reciprocals of a harmonical progression form an arithmetical progression, but that the general term of this arithmetical progression is of the form written down in elementary text-books on algebra.[2] Or, again, the discussion of the details of an example which would be in a more proper place in a school text-book or examination paper on elementary trigonometry.[3]

Mr. Lanchester's book, of which the first volume has been noticed in NATURE and the second will be reviewed shortly, should open the eyes of many would-be aëronauts as to the complex theoretical investigations which have to be mastered in any attempt to reduce the problem of flight to an exact science. Although the author has purposely avoided, so far as possible, the use of mathematical formulæ, the reader who aspires to revolutionising the flight problem without making actual experiments and without an extended study of mathematical or physical principles will find the book a pretty hard nut to crack.

The time has, however, passed when any useful

[1] *Cornhill Magazine*, May, 1907.
[2] *Aëronautical Journal*, April, 1908, p. 27.
[3] *Aëronautical Journal*, January, 1904, pp 4, 5.

purpose can be served by merely writing to the effect that the proper way of solving the problem of flight is by means of vertical screws or by imitating the action of birds' wings. When people can fly for an hour by one method they will scarcely be likely to try another. An actual demonstration of either of these alternative methods as applied to a man-carrying machine would, of course, be watched with considerable interest. Whatever may be the best and cheapest way of advancing aëronautical knowledge, it is probable that the human element and the feeling of "every man his own flying-machine" will appeal most to the Englishman, and more scientific methods will appeal more to the German, who has already arranged for translations of Mr. Lanchester's works.

Mr. Herbert Chatley[1] has directed attention to the part played by eddy formation in determining the flow of air in the wake of aëroplanes. This factor may introduce dangers in a flying-machine should the rate of eddy formation coincide with the period of free oscillation. Accidents from a similar cause have frequently occurred in other branches of engineering, and it seems very probable that some day we shall have an object-lesson of the kind in aëronautics. But the study of these eddies affords an interesting recreation for those who like to look into the matter. The side of a ship is a good place for watching eddy formation, but a better place is a dusty road along which motor-cars are passing. Here anyone can see the eddies being thrown off at perfectly regular intervals, each picking up a separate cloud of dust and whirling it high into the air. If the observer cared to carry his researches further he might get a motor-car, and try attaching tails of different sizes and shapes to it until he got one in which the eddy formation was reduced to the smallest possible amount, and the air resistance would probably be also reduced. He would not succeed in abolishing dust altogether, nor would he make a fortune by taking out a patent; but he would discover a more effectual means of reducing the dust nuisance than by writing complaints to the newspapers.

G. H. BRYAN.

## *MARINE BIOLOGY.*

THE work of the Danish naturalists on behalf of the International Commission for the Investigation of the Sea is greatly enriching our knowledge of the natural history of important sea-fishes. In "Serie Fiskeri," Bind ii., Nos. 5-8, of the Danish "Meddelelser fra Kommissionen for Havundersøgelser," there are several important papers by Dr. Johs. Schmidt, a naturalist well known for his discovery of the breeding-places of the common eel of European rivers.

In No. 6 Dr. Schmidt records the results of marking experiments with plaice and cod in the waters around Iceland. Of numerous mature plaice caught, labelled, and liberated in the summer of 1905 off the north and east coasts respectively, those re-captured of the former batch were found to have travelled westward, the latter southwards along the east coast and then westwards along the south coast, *taking in each case the shortest route to the warm Atlantic waters.* Here in winter and spring they spawn. The eggs and fry are then carried passively along by the Atlantic stream (Irminger current), which sets eastwards in spring and summer, and the just-transformed young appear successively in the bays and fjords, first on the west, later on the north, and later still on the east coast. Immature cod, caught, labelled, and liberated at the same time as the plaice on the north-east coast, did not migrate, but remained on that coast throughout winter, and even for one to two years after liberation. It was also found that one-year-old cod were much more numerous on the east coast than on the south and west. On the other hand, the eggs of the cod was absent in hauls with pelagic nets made on the north and east coasts, but plentiful on the west and south. From these facts it appears that the peculiar hydrographical conditions round Iceland involve a double migration of considerable extent on the part of cod and plaice, viz. (1) the passive drift with the eastward-setting Atlantic stream of eggs and fry born off the south and west of the island; (2) the active return migration of spawning fishes to the warm water, due to their special sensitiveness to external conditions on the approach of the spawning season.

Another noteworthy result of these marking experiments is to show that Iceland plaice grow at an average annual rate of 2–3 centimetres, much slower, therefore, than in the North Sea. The most obvious cause of this is the low temperature of the water, on the east and north coasts especially, and the short summer. It is also interesting, from the practical fishery standpoint, to note that more than 60 per cent. of the re-captured marked plaice were taken by English steam trawlers.

Hitherto the post-larval stages of those North Atlantic gadoids, viz. the hake (*Merluccius vulgaris*), *Molva elongata*, and *Raniceps raninus*, have not been described or figured in literature. In No. 7 Dr. Schmidt gives descriptions and figures of thirteen different post-larval stages of the hake. All these were carefully identified with the adult by counting the numbers of vertebræ and fin-rays. The paper also contains a summary of the distinctive characters of various gadoids in the post-larval stage.

In No. 8 there are described seven different post-larval stages of *Raniceps raninus*, a remarkable-looking plump form, somewhat resembling a post-larval Liparis species, and differing from other post-larval gadoids in not possessing the usual three post-anal bars of pigment. In this number also are described and figured four different post-larval stages of *Molva elongata* and *Molva byrkelange*. These two forms, in regard to which Holt and Byrne thought "a single species was enough for the reception of both," are shown to have perfectly distinct post-larval forms with characteristically different arrangements of pigment. The geographical distribution of the two forms, as Dr. Schmidt points out, is also quite different, so that there can now be no doubt that we have to deal with two species.

In No. 5 Ove Paulsen describes and figures all the species of Peridiniales so far known to occur in Danish waters. The Peridiniales are a most important group of unicellular organisms from the standpoint of the student of plankton, since certain species of them appear to be characteristic of water of neritic and oceanic origin respectively. The descriptions appear to be adequate, and there are usually figured several different views of each form. There is also a copious list of literature at the end.

## *NOTES.*

AT the general meeting of the Royal Society of Edinburgh, held on October 26, Sir William Turner, K.C.B., F.R.S., was elected president of the society.

THE King has granted his Royal licence and authority to Dr. Ludwig Mond, F.R.S., to wear the decoration of the Grand Cordon of the Crown of Italy conferred upon him.

[1] *Aëronautics*, August, 1908.

THE organising committee of the Anthropological Congress has postponed the date of the fourteenth congress. Instead of being held at Dublin in 1909, it will take place in 1910.

THE opening meeting of the new session of the Institution of Electrical Engineers will be held on Thursday, November 12, when the president, Mr. W. M. Mordey, will deliver his inaugural address.

THE council of the Institution of Civil Engineers has made the following awards for the year 1907–8:—Telford gold medals to W. B. Parsons and Dr. H. Lapworth; a Watt gold medal to Sir Whately Eliot; George Stephenson gold medals to Sir John W. Ottley, K.C.I.E., Dr. A. W. Brightmore, J. S. Wilson, and W. Gore.

PROF. R. H. CHITTENDEN, director of the Sheffield Scientific School of Yale University, has, we learn from *Science*, been appointed the University's representative at the Darwin celebration to be held at the University of Cambridge next June.

THE death is announced, at sixty-two years of age, of M. Gustave Canet, president of the Junior Institution of Engineers. M. Canet was president of the Institution of Civil Engineers of France, and one of the founders of the French Association for the Advancement of Science.

THE death is announced of M. Paul Berger, the eminent French surgeon. M. Berger was a member of the Paris Academy of Medicine, and took an active and authoritative part in the discussions of the society. He also belonged to the French Anatomical Society and to the Société de Chirurgie, of which he was president.

THE *Pioneer Mail* understands that a special pension has been granted by the Government of India to Dr. Eugen Hultzsch, who recently retired from the editorship of *Epigraphia Indica*, the journal of Indian antiquarian research, in recognition of his services to Indian archæology. Dr. Hultzsch went out to the archæological department in India in 1886.

THE death is announced of Dr. Cuthbert Collingwood at the age of eighty-two. Dr. Collingwood was elected a Fellow of the Linnean Society so long ago as 1853, and was a foreign member of the Physico-Economic Society of Königsberg. He was the author of "Rambles of a Naturalist in the China Seas," and of various scientific papers in the Transactions of the Linnean Society and other publications.

THE annual Huxley memorial lecture of the Royal Anthropological Institute will be delivered by Prof. W. Z. Ripley, of Harvard University, on Friday, November 13, at 8.30 p.m., in the theatre of the Civil Service Commission, Burlington Gardens, W. (by permission of the First Commissioner of Works). Prof. Ripley has taken for his subject "The European Inhabitants of the United States." Tickets can be obtained on application to the secretary of the Royal Anthropological Institute, 3 Hanover Square, W.

THE annual general meeting of the Junior Institution of Engineers was held at the Royal United Service Institution, Whitehall, on October 19, the chairman, Mr. Frank R. Durham, presiding. The report of the council referred to the election of Mr. James Swinburne, F.R.S., as president in succession to the late M. Gustave Canet. Special reference was made to the foundation of the Durham bursary, due to the kindness of Mrs. F. R. Durham. The award for the year 1908–9 has gone to Mr. L. M. Jockel, of Edinburgh, his thesis being on the subject of electricity in mining.

WE notice with regret the death, in his seventy-fourth year, of Mr. Henry Chapman, who did notable work in the development of the application of machine tools actuated by hydraulic power, the perfecting of torpedo machinery, and with air compressors. He introduced the Giffard injector into this country, and was one of the pioneers of the principle of distributing high-pressure water. Mr. Chapman was elected vice-president of the Institution of Mechanical Engineers in 1907. He belonged to the Iron and Steel Institute, and was a member of the Institution of Civil Engineers and of the Institution of Naval Architects. He was decorated by the French Government in 1878 as Chevalier of the Legion of Honour, and was promoted to the rank of officer in 1889.

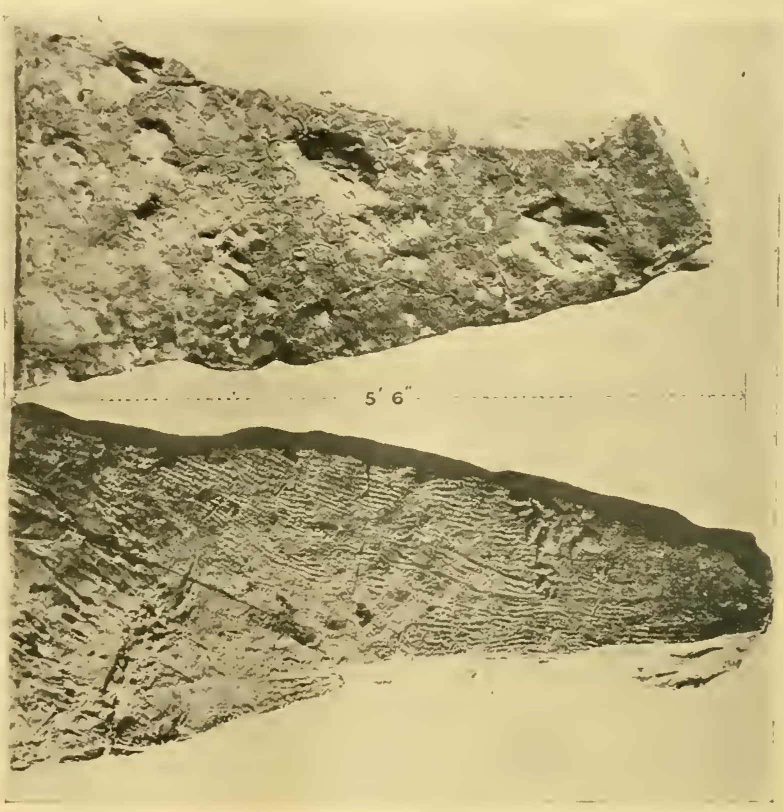
THE International Electrotechnical Commission held its first council meeting at the new home of the Institution of Electrical Engineers, on the Victoria Embankment, on October 19. The Right Hon. A. J. Balfour welcomed the delegates of eighteen countries, and spoke of the intimate relations existing between theory and practice in electricity. From the report of Colonel R. E. Crompton, it appears that electrotechnical committees have been officially constituted in ten countries, while in six other countries committees are to be formed in the near future. The French committee urges the adoption of the metric system, and has also raised the question of a provisional standard of light. The council in committee is also to deal with matters relating to nomenclature, symbols, and regulations for fire insurance for interior electrical wiring.

WRITING to the *Times* of October 24 with reference to the destruction of ancient monuments on Dartmoor, Mr. G. Hubbard states that on Bush Down the sockets may be seen on the side of the hill where an alignment of stones was torn up four years ago, and that portions of another stone alignment on the common land on the same Down have within recent weeks been converted into road metal. It appears to be a common practice with road-makers in the district to collect stones from the moor and to break them up into road metal. One road-maker questioned by Mr. Hubbard said he had no definite instructions as to which stones to use for this purpose, but "he always took those which were handiest." If local authorities and landowners would insist that the stones for road-mending should be obtained from roadside quarries, some check would be placed upon these deeds of vandalism while we are awaiting an Act to render such proceedings illegal.

IT will be remembered that on February 20 last Prince Roland Bonaparte placed at the disposal of the Paris Academy of Sciences four yearly sums of 25,000 francs for the encouragement of scientific research among men of science not belonging to the academy. The grants are intended exclusively to encourage discoveries and to assist scientific workers who, having accomplished some successful original research, are unable for want of sufficient funds to undertake or to complete investigations. The first grant was made by the academy last June, in accordance with the report of a special commission. The three next annual grants will be made on July 15 of each of the three years 1909–11. No grant of less than 2000 francs will be made. Men of science desirous of participating in the awards must apply to the academy, either directly or through a member of the academy, before January 1 of each year. A precise statement of the work proposed to be carried out, and the amount necessary for its completion, must be made. Beneficiaries will be expected to report to the academy within twelve months how the grant has been expended, and the results obtained. Non-compliance with this rule will disqualify for future grants. The first announcement of any results must in all cases be made to the academy.

The annual dinner of the Institution of Electrical Engineers was held at the Hotel Cecil on October 22, when some of the delegates to the International Conference on Electrical Units and Standards and to the International Electrotechnical Commission were present. Mr. Haldane proposed the toast of "Science and Industries." "A few years ago," he said, "it may have seemed as if the domination of science over what science is applied to had its highest illustration in the application of pure mathematics to physics. But we seem to have got a stage beyond that. There is a topic which is of fascinating interest, and that is the domination which a new generation altogether of pure mathematicians are asserting over the old mathematicians. The conception of number which many people think they are quite familiar with has proved to be quite obscure. In days which are long gone by, people were content to take the motion of a point in space, the line of the curve it described, and accept that as the ultimate standard by which to bring their mathematical theories to the test. On it they based the infinitesimal calculus, just as physicists have been engaged for the last fortnight in seeking standards on which to base and test their electrical practice. But in these days, when everything is questioned, there has arisen a new school which has brushed aside the old notions of space as an exact test to which to refer the mathematical theories of the day. This is a sign of the times and an indication of how men are asserting the necessity of absolute and clear conceptions as the basis of everything. Whether we take a great industry like the telephone, or such things as the science of aërial navigation, it requires a great deal of science to be applied to it before we get it on to a secure basis. Or, if we take the conceptions of the higher mathematics to-day, we are faced with the same tendency which keeps men always busy, always striving after some more general conception to which to refer back what is being worked at. We cannot stand still. In every nation more and more one is impressed with the special excellences which are being developed, with the way in which new men are coming to the front and new truths are being born. And there is this great satisfaction, that there is no real rivalry in the search after truth. Everyone is proud of the contribution of his neighbour, of whatever race. We must bear in mind that all men of science, of whatever nationality, are converging on a common problem when working at the application of science to industry."

There has recently been placed on exhibition in the British Palæontological Gallery of the Liverpool Museum a slab of Keuper sandstone taken from a quarry at Storeton, Cheshire, which well illustrates almost all the varied traces of life of the Trias found in the neighbourhood. The slab was quarried about 50 feet from the surface, at the level recognised locally as the "footprint beds." It is about 8 inches in thickness, and exhibits impressions on both surfaces—as indentations on what *in situ* was the upper surface, and in relief on what was the under surface. The impressions consist of well-marked footprints of both fore and hind feet of the labyrinthodont Chirotherium in




Footprints and other markings upon a slab of Keuper Sandstone in the Liverpool Museum.

several well-defined tracks, footprints of the rhynchocephalid Rhynchosaurus, and casts of a group of fragments of stems of the fossil genus of plants Equisetites. The type-specimen of *E. keuperina*, also from Storeton, is exhibited in an adjoining case, and the casts on the slab are either the same species or closely allied to it. The joints or nodes and the grooving of the stem are distinctly seen. The slab also exhibits good examples on one side of "ripple marks" and on the other of "sun cracks," and altogether forms a rather unique museum specimen.

In reply to an inquiry as to what hardy flowering plants and shrubs are especially attractive to butterflies, Mr. R. Hooper Pearson has sent us the following information :—

Among plants which are most frequented by butterflies are those following:—*Sedum spectabile*, *S. Sieboldii*, *Reseda odorata* (mignonette), *Cistus ladaniferus*, *Limnanthes Douglasii*, *Borago officinalis* (Borage), *Pulmonaria officinalis* (lungwort), *Viola odorata* (sweet violet), *Alyssum maritimum* (sweet Alyssum), *Phacelia tanacetifolia*, *Gilia tricolor*, *Gilia nivalis*, *Aster Amellus*, and Helianthus (sun-flowers); but almost all flowers that produce honey or nectar are visited by butterflies as well as bees, though the construction of some flowers prevents the butterflies and bees from reaching the nectar secreted in them. Among "honey" flowers may be mentioned Apple, Apricot, Peach, Pear, Plum, Cherry, Raspberry, Blackberry, *Anchusa italica*, Arabis, Wallflower, Crocus, Snowdrop, Godetia, Lupin, Magnolia, Maple, Salvia, Phlox, Scabious, Sage, Malope, Ivy, *Cercis Siliquastrum* (Judas tree), *Tilia vulgaris* (lime), common Thyme, *Tropaeolums majus* and *minus*, *Wistaria sinensis*, *Acer pseudo-platanus* (sycamore), *Vitis vinifera* (grape vine), Fragaria (strawberry), Cytisus, Ribes (currant), Acacia, Clarkia, *Ribes grossularia* (gooseberry), Asparagus, Trifolium (clover), Collinsia, Cucumis (cucumber and melon), Genista, *Nepeta Glechoma* (ground ivy), Erica (heather), Leptosiphon, Allium (onion), and Vicia (vetch). If it be desired to attract butterflies permanently to the garden, means should be taken to prevent sparrows becoming numerous, as these birds have been observed in the act of eating the perfectly developed butterflies.

The *Philippine Journal of Science* for July (iii., No. 3) contains several important papers, notably one by Assist.-Surg. Garrison on the prevalence and distribution of the animal parasites of man in the Philippines, and another by Dr. Strong on the diagnosis of African tick fever and the differentiation of the species of human spirochætes.

It has been found by Bail and others that blood serum, and particularly the serum of pathological exudates, may favour infection by micro-organisms. Thus a germ-free exudate, harmless in itself, may, if mixed with a non-harmful dose of a pathogenic bacterium, cause a fatal infection. Bail has supposed that substances derived from the bacteria are present in the exudate, which neutralise or antagonise the natural defences of the body; to such substances the name of "aggressins" has been applied. Cole and Smirnow have found that normal pigeon and rabbit sera exert an "aggressive" effect with the pneumococcus, and suggest that this may therefore be due to the natural toxic action of serum, and not to the hypothetical aggressins derived from bacteria in serum exudates (Bull. Johns Hopkins Hosp., September, 1908, p. 249).

Dr. F. A. Bather was mentioned in a brief note (Nature, October 15, p. 609) on Mr. A. H. Clark's paper on the nomenclature of crinoids. The note apparently suggested that he had attempted to revise the names of the crinoid genera, which number some 500, and that, in Mr. Clark's opinion, he was only right in two cases. This is not the case. The facts are stated by Dr. Bather as follows:—"In his most useful revision of the nomenclature of the *recent* crinoids, Mr. Clark refers to my essay on 'Pentacrinus: a Name and its History' (1898), which dealt with the numerous names applied at different times to five genera, and apparently he agrees with me as to the names to be applied to four of these genera. As to the fifth, I may have been wrong in adopting Encrinus from C. F. Schulze; but that is a matter of opinion."

Mr. F. A. Lucas, curator-in-chief of the museums of the Brooklyn Institute of Arts and Sciences, in his report for 1907 directs attention to the opening of the new eastern wing of the main building. He adds that, for want of sufficient case-room, he has found it impossible to put the natural exhibits in the condition in which he should like to see them. He hopes, however, that in the course of the next two years it will be possible to do more in this respect than it has been found practicable to accomplish during the past decade. The museum sent a collecting expedition to Venezuela and Trinidad, of which an account will be found in the report, which also contains a history of the rise of the Brooklyn Museum.

We have received from the publishers—Messrs. Macmillan and Co., Ltd.—two samples of a series of coloured pictures of farm animals, reproduced in chromolithography from paintings by Mr. J. Macfarlane. Each picture measures 30 inches by 20 inches, and the animal occupies nearly the whole length of this space, so that the series is suitable for display in large rooms, such as schools and colleges. The animals depicted are all prize-winners or champions, those shown in the samples received being the shorthorn "Sweetheart" and the Ayrshire "Adamhill Bertha 2nd." The reproductions appear singularly successful, and as the surface is highly glazed, the pictures can be framed and hung without glass. In connection with this subject it may be mentioned that, on the closing of the exhibition at Earl's Court, the Hungarian Minister of Agriculture presented to the natural history branch of the British Museum a number of the beautiful miniature models of domesticated horses, cattle, sheep, pigs, and poultry executed by Mr. Georges Vastagh, of Budapest.

The female crayfishes of the genus Cambarus inhabiting America east of the Rocky Mountains have long been known to differ from their relatives of other parts of the world by possessing special receptacles for the sperm in the shells; the sperm in other species being deposited on the general surface of the shell. The examination of a Cuban and a Mexican species has now enabled Mr. E. A. Andrews to state (Proceedings of the Washington Academy of Science, vol. x., p. 167) that the presence of sperm-receptacles is common to all the representatives of Cambarus, as it is to the American lobster. These chambers, although occurring in both groups on the under surface of the body, do not, however, correspond structurally, the receptacle in the lobster being an external space roofed over by the annular plate of the seventh thoracic segment, whereas in the crayfishes it is a narrow pocket excavated in the same plate.

In a supplement to the Journal of the South African Ornithologists' Union for 1908, issued as a separate pamphlet of the Bird Protection Committee of the union, Mr. Alwin Haagner discusses the economic relations of the local birds-of-prey and the treatment they deserve at the hands of the agriculturist and stock-owner. Throughout the world most birds-of-prey, both diurnal and nocturnal, are the subject of suspicion or persecution, and it appears that quite recently the Transvaal Game Protection Association offered a reward for the destruction of hawks of all kinds, a proceeding which gave rise to a protest from the author of the present pamphlet. With the possible exception of Pel's fishing-owl, which may kill guinea-fowls, all the nocturnal species are wholly beneficial, as are also very many of the diurnal group, including all the vultures. A certain number of diurnal birds-of-prey, such as the crested hawk-eagle and the bateleur eagle, are partially beneficial and partially harmful, while a small group, including most of the eagles and a few hawks, is held to be wholly mischievous.

WE have to acknowledge the receipt of a copy of vol. ix. (ser. 3) of the *Anales del Museo Nacional de Buenos Aires*, several of the articles from which have already been noticed in our columns. Among those not so mentioned, reference may be made to two by Mr. F. Lahille on Argentine cetaceans, one relating to a supposed new species or subspecies of dolphin of the genus Tursiops, and the other to the occurrence of *Balaenoptera acutirostrata* (=*rostrata*) in the South American Atlantic. As regards the former, it will suffice to mention that the author appears to be unacquainted with the papers on the dolphins of this group contributed by Mr. Lydekker to the Journal of the Bombay Natural History Society and the Proc. Zool. Soc. In connection with the second, it is remarkable that the author once more resuscitates the (we had heard obsolete) theory of the descent of cetaceans from ichthyosaurs. Here again we note the absence of any reference to Dr. Fraas's proof of the origin of the presumably cetacean zeuglodonts from primitive Eocene land Carnivora.

WE have received two bulletins from the Experiment Station of the Colorado Agricultural College. No 130 deals with the evergreen trees of Colorado, and describes the native pines, spruces, firs, junipers, and red cedars from the botanical and economic point of view. There are several good illustrations. No. 128 deals with lucerne. Attention is directed to the fact that lucerne, being a deep-rooted leguminous plant, increases the supply of nitrogen and of organic matter in the soil, and thus tends to maintain the fertility of land which is being heavily cropped with sugar beets and other exhausting crops. Numerous varieties are described, and their relative values under the conditions of the trial are indicated.

INCREASING attention is now being devoted to the production of cacao in the West Indies, and some account of the investigations on this crop made by the scientific staff of the Department of Agriculture is given in the West Indian Bulletin, vol. ix., No. 2, and in a recent issue of the *Agricultural News*, the periodical published by the Department. Fertiliser experiments have been made to discover the sort of manuring necessary, and attempts have been made to improve the crop by selecting promising sorts and then propagating them by grafting or budding. The various diseases to which the crop is liable have also been studied, and systematic operations started for coping with them. The whole work furnishes another example of the great benefit conferred on the industries of the West Indies by the scientific staff.

BULLETIN No. 113 of the West Virginia Agricultural Experiment Station gives some interesting notes on the habits of mice, voles and shrews, particularly from the economic standpoint. The short-tailed shrew (*Blarina brevicauda*) is considered to be beneficial to farmers, and is recommended for protection. Brewer's mole (*Parascalops breweri*) may do a certain amount of injury because of the number of earthworms it eats, and the rather unsightly mounds of earth it throws up, but it destroys so many grubs that on the whole it is classed as useful. On the other hand, the various field mice, of which two are described (*Microtus pennsylvanicus* and *M. pinetorum scalopsoides*) are regarded as wholly injurious, and their destruction by strychnine is urged. The bulletin is well illustrated with photographs.

IN *Symons's Meteorological Magazine*, July–September, the Rev. D. C. Bates describes some recent and costly rain-making experiments by gun firing in the Oamaru district of New Zealand, which may be considered useful in so far as they once more prove their absolute futility. From various causes the district is subject to long droughts; an influential committee was formed to organise the experiments, for which a large sum of money was readily subscribed, and was supplemented by the Government, Mr. Bates being requested to watch and report upon the results. The weight of the charges varied from 50 lb. to 200 lb.; these were primed with dry gun-cotton and fired by a dynamite detonator attached to a slow burning fuse, and in nearly all cases complete detonation took place. The times chosen for the experiments were generally those when atmospheric conditions were considered to be favourable for rain. Although rain occasionally fell within a reasonable time, Mr. Bates could only conclude that it was a mere coincidence, and that "the explosions had apparently no more effect on the vast expanse of the air than would the striking of a match in a room."

IN a short note in the *Annals of Mathematics* for July, Prof. J. L. Coolidge proves a theorem, which he states he has not previously seen, according to which, if a set of ratios between positive integers are equal to one another, then all are equal to the ratio of the greatest common divisor of the numerators to that of the denominators, and also to the corresponding ratio of the lowest common multiples.

MESSRS. B. G. TEUBNER, of Leipzig, have issued an elegantly bound volume, of more than 500 pages, containing a catalogue of their published works on mathematics and allied sciences. To the English reader this list should afford an object-lesson as to the value which is attached to scientific progress and advancement by our German rivals. The book was prepared for the International Mathematical Congress at Rome this spring. It is illustrated by portraits of eminent mathematicians, including a frontispiece of Galileo Galilei, and in addition to alphabetical and subject indices it contains an introductory account of the principal works published by the firm from the middle of last century, and a calendar of births, deaths, and other important events in the mathematical world, by Prof. Felix Müller, of Dresden.

A NEW work is announced for early publication by Mr. Elliot Stock, under the title "Saint Gilbert: the Story of Gilbert White and Selborne," by Mr. J. C. Wright.

PROF. R. W. WOOD has written another amusing set of verses for children, illustrated with quaint drawings. Attention was directed on a previous occasion to the character of the volume "How to Tell the Birds from the Flowers." The present volume is entitled "Animal Analogues," and is published by Messrs. Paul Elder and Company, of San Francisco and New York. Its price is 50 cents net.

THE best form of the mariner's compass card, so described and reproduced in NATURE of September 24 (p. 509), is the registered design of Mr. F. Howard Collins, of Torquay, and has been awarded a diploma for bronze medal at the Franco-British Exhibition. A specimen of Mr. Collins's card was submitted to us two years ago, and was commented upon at that time (vol. lxxiv., p. 594).

WITH reference to the review of "Science and Empiricism" (NATURE, October 15, p. 603), Mr. Daniel writes that cancer must be due to loss of energy in the cell, and not to bacteria. This point was not referred to in the review; in fact, the trend of opinion at present is against the parasitic origin of cancer. The reviewer took exception to the extremely imaginative conception of the cancer process as expressed in the book.

A SIXTH edition of Prof. Strasburger's "Handbook of Practical Botany," translated and edited by Prof. W. Hillhouse, has been published by Messrs. Swan Sonnenschein and Co., Ltd. Considerable textual revision has been effected, some new figures have been introduced, the chapter on cell and nuclear division has been in part re-written, and Prof. Hillhouse has rearranged the material in such a way as to illustrate grades in cytological technique.

MESSRS. A. E. STALEY AND CO., Thavies Inn, London, E.C., have forwarded us a copy of the September issue of *Prism*, a little magazine published by Messrs. Bausch and Lomb Optical Co., Rochester, N.Y., U.S.A. This issue deals popularly with the manufacture of the microscope. Messrs. A. E. Staley and Co., who are the exclusive agents of the American company in England and the colonies, will send a copy of the magazine to any interested reader on receipt of a stamp for postage.

MESSRS. LONGMANS, GREEN AND CO. have published a second edition of Mr. J. P. Johnson's "The Stone Implements of South Africa," which was reviewed at length on its first appearance in our issue for May 30, 1907 (vol. lxxvi., p. 99). The volume has been revised and enlarged, further discoveries of the author have been incorporated, and a number of new illustrations added. The comprehensive terms adopted in the first edition have been replaced by the current European nomenclature, though most of the data remains the same. The volume possesses neither index nor table of contents. The price of the new edition is 10*s*.

## *OUR ASTRONOMICAL COLUMN.*

ASTRONOMICAL OCCURRENCES IN NOVEMBER:—

Nov. 4. 21h. 10m. Saturn in conjunction with the Moon (Saturn 2° 42′ N.).
,, 11h. 16m. to 13h. 56m. Occultation of 30 Piscium (mag. 4·7).
9. 8h. 16m. to 9h. 14m. Occultation of ε Tauri (mag. 3·7).
10. 9h. 45m. to 10h. 29m. Occultation of ο Tauri (mag. 4·8).
12. 10h. 58m. Neptune in conjunction with the Moon (Neptune 2° 36′ S.).
13. Mercury at greatest elongation, 19° 18′ W. of the Sun.
16. 21h. 42m. Jupiter in conjunction with the Moon (Jupiter 4° 20′ S.).
20. 3h. 42m. Venus in conjunction with the Moon (Venus 3° 6′ S.).
,, 9h. Vesta in conjunction with the Moon (Vesta 0° 40′ N.).
21. 23h. 16m. Mercury in conjunction with the Moon (Mercury 1° 55′ S.).
23. 15h. Ceres in conjunction with the Moon. (Ceres 0° 14′ N.).
26. 14h. 6m. Uranus in conjunction with the Moon (Uranus 1° 17′ N.).
30. 11h. 15m. Venus in conjunction with Mars (Venus 1° 17′ N.).
,, 8h. 46m to 9h. 50m. Occultation of $\tau^2$ Aquarii (mag. 4·3).

MOREHOUSE'S COMET, 1908*c*.—This object has now become visible to the naked eye, and may be picked up, on a clear night, by any keen-sighted observer who has an idea of its approximate position. Photographs taken at the Solar Physics Observatory, South Kensington, with the 6-inch Dallmeyer camera on October 23 show tails nearly 2° in length, whilst those taken with the 36-inch reflector show a complex series of streamers going to the edge of the plate.

Observations recorded in No. 4277 of the *Astronomische Nachrichten* (p. 84, October 20) appear to confirm the suggestion that the comet and tail have suffered some remarkable changes in visibility. Dr. H. Thiele states that both the length and breadth of the tail and the visibility of the comet have varied. According to his observations the length of the tail has varied between 10′ and 2°, and the breadth, within 10′ of the nucleus, from 15° to 40°; the dates of the longest and narrowest tails were September 12?, 15, 20, 23–27, October 4 and 5.

Prof. Hartwig also reports changes from October 2 to October 5 and 6, and suggests a periodic outrush of tail material.

A telegram from Prof. Pickering to the Kiel Centralstelle states that Messrs. Metcalf and Morehouse each announce a remarkable change in tail of Morehouse's comet on October 15, a change which is confirmed by the Harvard observations.

We give below part of the ephemeris published in No. 4276 of the *Astronomische Nachrichten* by Prof. Kobold, and the accompanying chart indicates approximately the


Path of Comet 1908*c*, October 24 to December 2, 1908.

position of the comet, in regard to the brighter stars, according to this ephemeris, for every alternate night from October 24 to December 2.

*Ephemeris 12h. M.T. Berlin.*

| 1908 | α (true) h. m. | δ (true) ° ′ | log *r* | log Δ | Brightness |
|---|---|---|---|---|---|
| Oct. 28 | 19 1·2 | +27 58·6 | 0·1369 | 0·0443 | 5·6 |
| 29 | 19 0·2 | +26 27·5 | | | |
| 30 | 18 59·3 | +24 58·4 | | | |
| 31 | 18 58·5 | +23 31·4 | | | |
| Nov. 1 | 18 57·7 | +22 6·5 | 0·1222 | 0·0629 | 5·5 |
| 2 | 18 57·0 | +20 43·7 | | | |
| 3 | 18 56·3 | +19 23·0 | | | |
| 4 | 18 55·7 | +18 4·3 | | | |
| 5 | 18 55·2 | +16 47·7 | 0·1073 | 0·0836 | 5·4 |
| 6 | 18 54·7 | +15 33·2 | | | |
| 7 | 18 54·2 | +14 20·6 | | | |
| 8 | 18 53·8 | +13 10·0 | | | |
| 9 | 18 53·4 | +12 1·3 | 0·0923 | 0·1054 | 5·2 |
| 10 | 18 53·1 | +10 54·5 | | | |
| 11 | 18 52·8 | + 9 49·5 | | | |

EPHEMERIS FOR COMET TEMPEL$_3$-SWIFT, 1908*d*.—The recent observations of the Tempel$_3$-Swift comet have enabled M. Maubant to re-determine the most probable time for the perihelion passage and to calculate a new ephemeris. He finds that it is necessary to retard the time of perihelion 3·640 days, and this reduces the mean diurnal motion by 0″·38. As M. Bossert found that, in order to represent the 1891 observations correctly, he had also to diminish this factor by the same amount, it is suggested that this comet is subject to a negative acceleration such as was found by M. Schulhof for the Tempel$_2$ comet, and by M. Lamp for Brorsen's comet.

In the ephemeris, which covers the period October 20 to December 31, the actual positions for 12h. (Paris M.T.) are given for each day, and observations made on September 29 and October 7 show that the ephemeris was correct for R.A. but required corrections in declination of $+1'·7$ and $+1'·8$ respectively. During the period November 1 to December 31 this comet will, according to the ephemeris, apparently travel through the constellations Cancer and Leo, from $\alpha$ = 8h. 45·1m., $\delta = +24°\ 34'·9$, to $\alpha$ = 9h. 22·7m., $\delta = +14°\ 8'·4$ (*Astronomische Nachrichten*, No. 4277, p. 79).

EPHEMERIS FOR JUPITER'S EIGHTH SATELLITE.—An ephemeris showing the position of J viii. in regard to Jupiter has been computed by Messrs. Crawford and Etal, and is published in Circular No. 105 from the Kiel Centralstelle. The following is part of it, and gives the differences:—

*J viii. – ♃ for 12h. G.M.T.*

| | | $\Delta\alpha$ | | $\Delta\delta$ |
|---|---|---|---|---|
| | | m s | | |
| Oct. 27 | ... | −2 44·8 | ... | +26 56 |
| 31 | ... | −3 3·5 | ... | +27 14 |
| Nov. 4 | ... | −3 21·9 | ... | +27 28 |

SATURN'S RINGS.—Further particulars of the new dark ring surrounding the bright rings of Saturn are published in a message from Herr Schaer, of the Geneva Observatory, to No. 4277 of the *Astronomische Nachrichten* (p. 81, October 20). On October 8 the white ring was seen to be bordered by two narrow bands of a brownish hue. When the seeing was good both bands were seen beyond the edge of the planet's sphere, and from these observations M. Schaer concludes that there is a dark exterior ring somewhat similar to the interior crape ring. This new feature is difficult to see with the Cassegrain telescope of 40 cm. aperture, using powers of 270, 450, and 660.

Prof. Strömgren, observing Saturn at Copenhagen on October 10, was unable to see any extraordinary feature, nor could Prof. Hartwig, at Bamberg on October 10 and 11, confirm M. Schaer's observation. Similarly, Senor J. Comas Sola, who observed the planet under good conditions during the beginning of the month, states that he saw nothing abnormal.

## INTERNATIONAL CONFERENCE ON ELECTRICAL UNITS AND STANDARDS.

INTERNATIONAL agreement on the subject of electrical units was arrived at in Paris at the conferences of 1881 and 1884, and at Chicago in 1893. The results of these conferences have been of considerable value to electrical industries. In recent years, however, differences have occurred, partly in the definitions of the units and partly in their realisation, and the degree of precision in electrical measurements which is now possible rendered it necessary to remove these differences. The committee of delegates at the International Congress at St. Louis in 1905 expressed the desirability of summoning an International Conference on Electrical Units and Standards, and the British Government recently invited representatives from all the civilised countries of the world to discuss these subjects.

The conference was opened by the Right Hon. Winston S. Churchill, M.P., on Monday, October 12, at the rooms of the Royal Society. Delegates from twenty-four different countries, including Australia, Canada, and India, were then present. Mr. Churchill gave, as one of the main objects of the gathering, the establishment of a universal system of electrical standards acceptable to all.

Lord Rayleigh was elected president of the conference, and Dr. Glazebrook chairman of a technical committee, the members of which were nominated by the delegates.

Possibly the best general view of the results of the conference can be given by the reproduction of the first portion of Schedule B containing the resolutions which the conference adopted with the request that the delegates would lay these and the specifications which complete the schedule before their respective Governments with the view of obtaining uniformity in the legislation with regard to electric units.

*Resolutions.*

(1) The conference agrees that as heretofore the magnitudes of the fundamental electric units shall be determined on the electromagnetic system of measurement with reference to the centimetre as the unit of length, the gram as the unit of mass, and the second as the unit of time.

These fundamental units are (1) the ohm, the unit of electric resistance which has the value of 1,000,000,000 in terms of the centimetre and second; (2) the ampere, the unit of electric current which has the value of one-tenth (0·1) in terms of the centimetre, gram, and second; (3) the volt, the unit of electromotive force which has the value 100,000,000 in terms of the centimetre, the gram, and the second; (4) the watt, the unit of power which has the value 10,000,000 in terms of the centimetre, the gram, and the second.

(2) As a system of units representing the above and sufficiently near to them to be adopted for the purpose of electrical measurements and as a basis for legislation, the conference recommends the adoption of the international ohm, the international ampere, and the international volt defined according to the following definitions.

(3) The ohm is the first primary unit.

(4) The international ohm is defined as the resistance of a specified column of mercury.

(5) The international ohm is the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14·4521 grams in mass, of a constant cross-sectional area, and of a length of 106·300 centimetres.

To determine the resistance of a column of mercury in terms of the international ohm, the procedure to be followed shall be that set out in Specification A attached to these resolutions.

(6) The ampere is the second primary unit.

(7) The international ampere is the unvarying electric current which, when passed through a solution of nitrate of silver in water, in accordance with the Specification B attached to these resolutions, deposits silver at the rate of 0·00111800 of a gram per second.

(8) The international volt is the electrical pressure which, when steadily applied to a conductor whose resistance is one international ohm, will produce a current of one international ampere.

(9) The international watt is the energy expended per second by an unvarying electric current of one international ampere under an electric pressure of one international volt.

A comparison of these resolutions and those of the Chicago Conference will show two main changes.

In the first place there is no reference to the E.M.F. of a standard cell in the definition of the volt, while in the second the definitions of the international ohm, ampere, and volt have been made more precise. As to the first of these changes, after it had been decided that the volt was to remain a derived unit, there was no difference of opinion. The other, as a reference to the account of the proceedings will show, gave rise to much discussion. The increased precision, which it should be noted concerns the definitions of the units, and probably does not affect the concrete standards by which the units are expressed, is arrived at in two ways. In the first place, a distinction is drawn between the ohm—$10^9$ C.G.S. units of resistance—and the international ohm—the resistance of a definite column of mercury. Previously, some such phrase as that the ohm $10^9$ C.G.S. units "is *represented* by the resistance" of a certain column of mercury has been used; in the new resolutions it is stated that the international ohm represents the ohm *sufficiently nearly* for the purpose of electrical measurements and as a basis for legislation, and *is* the resistance of a certain column of mercury of length 106·300 centimetres. Precision is given in the second place by the addition of the 00 after the 3 in the above length, the international ohm being thus defined to one part in a hundred thousand.

It is not to be inferred from this that we know the ohm—$10^9$ C.G.S. units—to this accuracy in terms of mercury, and the difference between the ohm and the international ohm remains a matter for experiment, but resistances are compared to six or even seven figures, and it is requisite, therefore, for international purposes, that the unit in terms of which they are expressed should be defined with the same precision.

So, too, with the ampere; the definition has been rendered precise by stating that the international ampere is the current which, under certain conditions, deposits 0·00111800 gram of silver per second. In this case decision was rendered much more difficult by the fact that we know that in order to represent the ampere ($10^{-1}$ C.G.S. units) the last two figures should probably be 25 or 20.

The following is a brief *résumé* of the more important proceedings of the meetings.

In discussing the general question of the measurement of resistance by a mercury column, Lord Rayleigh expressed some doubt as to whether the introduction of such a column was not what is called a "fifth wheel to the coach." At the present time there was reason to believe that the ohm, as defined in absolute measure, could be arrived at with a very great degree of precision. He looked forward to the time when the column of mercury might be eliminated from the definition of the international ohm, and when the ohm, $10^9$ C.G.S. would be the standard.

Resolution 5, defining the international ohm, was introduced by Dr. Warburg (Germany). In discussing it Dr. Rosa (United States of America) raised the question whether it would not be better to specify the length of the column as 1 metre, and to give the weight accordingly, so that the resistance would be the same. The mass of mercury would then be 12·7898 grams instead of 14·4521. He suggested that if the specification for the international ohm was ever changed, and it probably would be as we came more nearly to the absolute value, it would be necessary to change both figures if the cross-section was to remain about 1 square millimetre. If the length were specified as 1 metre exactly, that would never be changed.

Dr. Rosa's suggestion was referred to the technical committee, and was not approved.

Mr. Trotter thought the resolution proposed by Dr. Warburg was something more than a confirmation of the ohm as established at Chicago. The scientific length was to be set aside and a conventional length declared, like the original Siemens unit. The two zeros after the 106·3 could have no scientific meaning. He thought the mercury column was an ingenious device which would serve a useful purpose, but there was no pressing need for it as a standard. While a useful result of the conference would be an organisation for the comparison of standards of different countries, it was questionable whether the differences which had to be reconciled were of sufficient importance to set aside the C.G.S. system and no longer to look upon it as the ideal. He thought it premature to add the two zeros to the 106·3, because it seemed likely that the Lorenz or some other mode of determination of the ohm would soon be made with an accuracy within a few parts in 100,000. Until that time arrived, mercury columns would be a temporary expedient.

Dr. Rosa, however, doubted whether the time was coming when resistances could be measured absolutely as accurately, and a series of determinations made to agree as closely, as mercury ohms could be set up and measured.

Dr. Warburg thought that the accuracy with which the proposed international ohm approached the true ohm was sufficient, and that an alteration in the international ohm should not take place in the future on account of its difference from the ohm ($10^9$ C.G.S.). He thought it of the utmost importance to preserve continuity.

In the end the resolution, as proposed by Dr. Warburg, was adopted.

The next matter taken up by the conference was the question whether the ampere or volt should be the second primary unit. In opening it, Dr. Glazebrook moved that the ampere be the second primary unit. The ampere has been defined by all congresses, with the exception of that of 1881, as the second primary unit, and he thought that as a standard the silver voltameter had a greater accuracy of reproduction than any form of standard cell. He directed attention to the following values obtained for the electrochemical equivalent of silver:—

| | | mgm. per coulomb |
|---|---|---|
| 1884. | Mascart ... ... ... ... | 1·1156 |
| 1884. | F. and W. Kohlrausch ... ... | 1·1183 |
| 1884. | Rayleigh and Sidgwick ... ... | 1·1179 |
| 1890. | Pellat and Potier ... .. ... | 1·1192 |
| 1899. | Kahle ... ... ... | 1·1183 |
| 1903. | Pellat and Leduc . ... .. | 1·1195 |
| 1904. | van Dijk and Kunst . . . | 1·1182 |
| 1906. | Guthe ... ... ... ... | 1·1182 |
| 1907. | Smith, Mather and Lowry .. .. | 1·1183 |
| 1908. | Janet, Laporte and de la Gorce .. | 1·1182 |

These results showed that the standard could be considered permanent and accurate; and still further confirmation is afforded by the fact that the Board of Trade ampere balance, which was adjusted fourteen years ago on the basis that the unit of current deposits 1·118 mgm. of silver per second, now gives for the equivalent of silver the value 1·11794—an extremely good agreement. A further reason for adopting the ampere as the second primary unit was that the absolute determinations of the ohm and the ampere were independent, and thus conformed more nearly to the theoretical ideal. This was of importance, as he hoped that some day we might arrive at standards which would measure resistance and current in absolute units direct. The chemistry of the silver voltameter had recently been investigated at the National Physical Laboratory; it was of importance to know that only one chemical had to be purified, and this (silver nitrate) one of extreme solubility in water, and therefore capable of purification by repeated crystallisation. No time had to elapse between setting up the voltameter and the attainment of a condition of chemical equilibrium. If secondary reactions took place, they were of very small importance, while it had been shown that the temperature coefficient was certainly not greater than 1 part in 1,000,000, and was probably smaller than this. Dr. Glazebrook did not suggest that the silver voltameter should be generally used for measurement of current; it was intended as an instrument to be used at standardising laboratories. For all ordinary measurements of current a standard cell and a resistance would still be employed. The Weston cell involved the purification of four substances, one of which (mercurous sulphate) was a very insoluble salt and very difficult of purification; moreover, there was a difference of opinion as to the best method for its preparation. If the volt were defined as a fraction of the E.M.F. of the Weston cell, the standard was certainly more concrete, but this was not very important for a standardising laboratory. Of between 300 and 400 cells set up at the National Physical Laboratory 80 per cent. agree within three or four parts in 100,000; but in the remaining 20 per cent. the differences may attain two in 10,000, and we do not know the reason of this. The results obtained by Prof. Janet, at the Laboratoire Central, showed that the permanence of the cell is far from certain, as the mean E.M.F. of one batch of cells dropped six parts in 10,000 in two years, and of another batch seven parts in 100,000 in one year. He agreed that an extraordinary concordance in the E.M.F. of Weston cells had been reached between the Bureau of Standards and the National Physical Laboratory, but it was requisite to obtain agreement with cells made at other places, and this had not yet been done.

Prof. Lippmann (France) was in favour of the volt as the second primary unit. He agreed with Dr. Glazebrook that everybody would use the cell in practical work. He considered that the volt was an independent unit and could be measured absolutely by means of a disc rotating in the earth's magnetic field. Subsequently M. Gerard (Belgium) pointed out that as this method involved the determination of the magnetic field of the earth, it was not comparable with the absolute measurement of current.

Prof. Carhart (U.S.A.) pointed out that the congress of 1881 proposed the volt as the second primary unit. In Germany all measurements of E.M.F. were made by means of a standard cell and resistance, and to all intents and purposes the E.M.F. of the Weston cell had been legalised, and the silver voltameter was very rarely set up. Lord Kelvin at one time standardised his current balances by means of the silver voltameter, but he abandoned it in favour of a cell and a resistance. He (Prof. Carhart) believed the cell to be a constant and a useful standard. With the absolute balance at the National Physical Laboratory the electrochemical equivalent of silver was not directly determined; it was the E.M.F. of a Weston cell that was first fixed. He considered this was the correct way. At the Board of Trade the balance had only been compared with the silver voltameter once during the past eight years. He did not consider the ageing of cells to be serious; if necessary they might be kept for only a few days or a week. Cells which were set up by unskilled persons should not be considered, as it was a primary standard which was under discussion.

Dr. Rosa contended that the voltage of the Weston cell should be defined and fixed; and that, since some uncertainty must be permitted in the value of its voltage or in the value of the electrochemical equivalent of silver, it should be in the latter, as it was infrequently used, and would therefore be of minor importance. He objected to the silver voltameter because it is not permanent; it only lasts so long as the current flows. It is not a concrete standard like the cell, and it is not portable. It is laborious in practice, and it determines electric quantity and not current. Regarding the choice between Clark and Weston cells, it was possible that the Clark cell was the more stable.

Dr. Warburg thought that mercurous sulphate, which is used as the depolariser in Weston cells, could not be well defined, and that many cells gave abnormal results because of this. In fact, mercurous sulphate had been so much studied during the past three years that the Weston cell of to-day was a new one. He agreed entirely with the views expressed by Dr. Glazebrook.

In the further course of the discussion the following table of results for the E.M.F. of the Weston cell was submitted for consideration[1]:—

*E.M.F. of Weston Normal Cell at 20° C.*

| | |
|---|---|
| National Bureau of Standards... | 1·01847 *v.* (first batch of cells) |
| | 1·01853 *v.* (second ,, ,, ) |
| National Physical Laboratory ... | 1·0182 *v.* |
| Laboratoire Central d'Électricité | 1·0187 *v.* |
| Lippmann and Guillet ... ... ... | 1·01825 *v.* (first group) |
| | 1·01819 *v.* (second ,, ) |

Any uncertainty in the value of the resistance in international ohms would, it was pointed out, naturally affect these values. Ultimately the resolution in favour of the ampere was carried by 19 votes to 4.

Considerable discussion took place on resolution 7, the definition of the second primary unit—the ampere. Some of the delegates wished the ampere to be defined as the unvarying current depositing silver at the rate of 0·001118 gram per second; other delegates desired 0·00111800, that is, they wished the ampere to be so defined that comparisons could be made within one part in 100,000. The delegates from the United States, Dr. Weber (Switzerland), and some others desired that the international ampere should agree as closely as possible with the ampere ($10^{-1}$ C.G.S.). The values suggested were 0·00111820 or 0·00111825.

After some preliminary discussion at which this divergence of view was made clear, the question of the exact number to be inserted in resolution 7, defining the ampere, was referred to the Technical Committee, and discussed by them at a long sitting. The suggestion was made that in the resolution the conference should be content to stop at the 8, but that in the specification or in the notes a statement should be made as to the figures to follow the 8 in measurements of precision, and this was at first accepted. When, however, an attempt was made to settle what these figures should be, agreement could not be reached, and ultimately it was arranged to report the various votes which had been taken in committee to the full sitting. Thus, when the conference took up the question again, resolution 7, defining the ampere as the current depositing 0·00111800 gram of silver per second, was still before them. In the discussion which ensued, Dr. Glazebrook, who moved the adoption of resolution 7, urged that as the object of the conference was to secure uniformity of international measurements to a high degree of precision, measurements of current to five or six figures at least were wanted, and that it appeared that our units must be defined to five or six figures. While the value chosen should approach the absolute C.G.S. value closely he did not think it essential to get as close as possible to this value. In the case of the ohm, 00 had been added to the 106·3 cm., and for consistency two more figures must be added after the 8 for the electrochemical equivalent of silver. He would prefer to add 00. If, in the future, it seemed possible to revert to the absolute units, the two standards might be changed together, but so long as the ohm could not be defined closely in terms of the C.G.S. system there was no real necessity to define the ampere closely.

Prof. Lippmann proposed that the international ampere shoud be defined as being equal to the ampere based on the C.G.S. system, but this proposal was not accepted. Mr. Trotter thought that nothing should be added after the 8.

Ultimately resolution 7 was carried in its original form by 21 votes to 3.

The question was again raised when the final report was submitted for approval. Dr. Carhart stated that the chief argument which had been brought forward in favour of the ampere as the second primary unit was the reproducibility of the silver voltameter and the concordant results obtained in determinations of the electrochemical equivalent of silver in different countries. Since that discussion, Dr. Rosa had received a cablegram from Washington stating that the value of the electrochemical equivalent of silver obtained with the aid of a current balance at the Bureau of Standards was 0·0011182, agreeing very closely with the last five determinations. Surely, if anything was to be added after the 8, the figures should be 20.

The majority of the delegates appeared to be, however, of opinion that the change in the equivalent should be made, if at all, at the same time as the change in the length of the mercury column, and in consequence the original decision of the conference was confirmed by a majority of 13 votes to 8, three countries not voting.

Specifications relating to mercury standards of resistance and to the deposition of silver were approved by the conference and included in Schedule B, while the duty of drawing up, as an appendix to the report, a series of notes to the specifications, and planning more fully the methods to be adopted to realise the units, was assigned to a scientific committee nominated by the president.

In cases in which it is not desired to set up the standards provided in the resolutions in Schedule B, the conference recommends the following as working methods for the realisation of the international ohm, the international ampere, and the international volt.

(1) *For the International Ohm.*

The use of copies, constructed of suitable material and of suitable form and verified from time to time, of the international ohm, its multiples and submultiples.

(2) *For the International Ampere.*

(*a*) The measurement of current by the aid of a current balance standardised by comparison with a silver voltameter; or

(*b*) The use of a Weston normal cell whose electromotive force has been determined in terms of the international ohm and international ampere, and of a resistance of known value in international ohms.

(3) *For the International Volt.*

(*a*) A comparison with the difference of electrical potential between the ends of a coil of resistance of known value in international ohms, when carrying a current of known value in international amperes; or

(*b*) The use of a Weston normal cell whose electromotive force has been determined in terms of the international ohm and the international ampere.

*Steps necessary to secure Uniformity of Standards in the Future.*

The conference expressed a wish that some permanent steps for securing uniformity of standards in the future should be taken, and for such a purpose recommended the

[1] To this table must be added the results just obtained by M. Pellat, which give the value 1·0184.

establishment of a permanent International Commission for Electrical Standards. Pending the appointment of this commission, Lord Rayleigh nominated a scientific committee of fifteen to advise as to the organisation of the commission and to formulate a plan to direct such work as may be necessary in connection with electrical standards all over the world. In order to facilitate this work, various standardising laboratories will be asked to cooperate with the commission, and to carry out, if possible, such work as it may desire. The question was discussed of enlarging the functions of the International Conference on Weights and Measures, so as to combine with it in future electrical conferences, and the opinion of the conference was favourable to such a combination.

It is hoped that the scientific committee will from time to time modify the notes accompanying the specifications as may be necessary, and that this will conduce to greater uniformity between the standards of the various countries.

## ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

THE meeting of the anthropological section of the British Association was amongst the most successful that has been held in recent years. The address of the president, Prof. Ridgeway, which has been reported in full in Nature, has already led to considerable discussion and promises to have a good effect, and the meeting, so happily inaugurated, has been fruitful of much good work. As has been noticeable for some time past, papers upon archæological subjects were by far the most numerous. It is to be regretted that the communications in physical anthropology, although of exceptional interest, were hardly so numerous as those interested in the welfare of the section would wish to see. It is to be feared that there is a tendency among physical anthropologists to submit the results of their work to bodies other than the association—a matter for regret in view both of the importance of this branch of the study of man and of the interest in the subject taken by the ordinary members of the association, as shown by the size of the audience usually attracted by such papers.

The papers on physical anthropology included an important communication by Prof. Symington, on certain changes in the lateral wall of the cranium due to muscular development. Observations were made upon the relation of the temporal muscle to the skull and brain from birth until adult life, and it was demonstrated that at birth the muscle was small compared with the brain case, and that consequently the temporal ridge was low at this period of life. After birth the muscle grows more rapidly than the lateral area of the skull, and gradually extends upon it, so that the temporal ridge reaches a much higher level than in the infant. This extension proceeds gradually, and is associated with that of the jaws and teeth, being independent of that of the brain.

In his paper on the significance of the so-called accessory dental masses sometimes found in the upper jaw-bones, Prof. Francis Dixon, from an examination of a series of young Ibo skulls, came to the conclusion that these masses do not represent the rudiments of aborted or vestigial molars, corresponding to the third premolars of the platyrrhine apes, but arise as unabsorbed portions of the second milk molar. It is an interesting question why these fragments are so frequently retained in certain races.

An important contribution to our knowledge of the Egyptian races was made by Prof. Elliot Smith in his paper on anthropological work in Egypt. In his opinion the present population is remarkably uniform, the range of variation being not appreciably greater than that of any other known race. The infusion of negro blood is very small in amount, and its effect is usually slighter than is commonly supposed to be the case. The negro influence is least marked in pre-dynastic times. In Nubia, which was always open to raids from the south, there is a much more marked negro element, and the population of this district may be said to be a hybrid one. There is also evidence of a Levantine element in the Delta as early as the time of the Pyramid builders. The Copts show the least resemblance to the ancient Egyptians, owing to intermarriage with immigrants of their own faith.

Other physical papers were one on the adult brain, by Prof. A. Fraser; the report of the Cretan Committee, which published a preliminary statement on Mr. Hawes's examination of the crania; and that of the Anthropometric Committee, which published a report giving the result of its deliberations for the last seven years.

Another paper, by Prof. Elliot Smith, on the history of mummification in Egypt, may be mentioned here. After showing how in pre-dynastic times the custom of burying bodies in the sand led to their preservation, the author suggested that the idea of preserving their dead by art must have occurred to the Egyptians by observing this phenomenon, more especially as the later custom of burying in coffins or rock-cut chambers led to the bodies' dissolution. The desire was, of course, prompted by religious beliefs. When exactly embalming was first attempted there were no data to show. Although the earliest bodies known to have been embalmed are of the tenth dynasty, there is some evidence to show that the custom was practised by the Pyramid builders. The process of mummification reached its highest development under the New Empire, although under the Middle Empire the general technique was that which was followed for the succeeding two thousand years. Further stages in the art were followed by a period of rapid decline.

An important paper on Rajputs and Mahrattas was contributed by Mr. Crooke, who criticised the views of Sir Herbert Risley on the origin of these peoples. On the evidence of anthropometry, the Rajputs have been classed as Indo-Aryans, but the evidence rather points to the conclusion that they are a status group, compounded from varied elements, and not an ethnical unit. The Mahrattas similarly are a status group, the basis being the Dravidian or indigenous Kunbi tribe. It was suggested that the uniformity which characterises the physical character of the peoples of the Punjab might be due to sexual selection and the influence of environment, which have to some extent been overlooked by ethnologists.

Dr. C. G. Seligmann gave an account of his recent expedition to the Veddas of Ceylon, who may be divided into three divisions, Veddas, village Veddas, and coast Veddas, characterised by different sociological features. The coast Veddas have borrowed largely from the Tamils, and the village Veddas have intermarried with the Sinhalese, but in spite of this the clan organisation of the wild Veddas largely remains. There is hardly any decorative art. Their cult of the dead has given rise to pantomimic dances, which are performed chiefly by men trained to invoke the spirits. In language the Veddas speak Sinhalese or Sinhalese dialects with the addition of a few words not obviously Sinhalese.

A collection of Dinka laws, made by Captain O'Sullivan, was read by Mr. E. Sidney Hartland. The Dinka government is patriarchal with male descent. An interesting custom is the legal fiction by which an heir is provided when the male line has died out.

The archæological papers were of a very varied character, but naturally a considerable part of the section's work consisted in discussing Irish antiquities, and here the section was at the advantage of meeting next door to the National Museum where the Irish collections are displayed, and Mr. Coffey and Mr. Armstrong, the keeper and chief assistant of the Department of Irish Antiquities, were assiduous in their efforts in showing members the magnificent collections which are in their charge. The section, moreover, was fortunate in hearing papers from both these gentlemen on subjects which they have made their own.

Thus Mr. Coffey presented three papers. The first, on the distribution of the gold *lunulae*, showed that whereas in Ireland sixty of these characteristic Irish ornaments had been found, only eighteen had been discovered in Great Britain and the rest of western Europe. This distribution points either to early raids on Ireland from the Continent or to an early trade for gold. The *lunulae* may be dated between 1200 B.C. and 1500 B.C. Another paper by Mr. Coffey was on the survival of La Tène ornament on some Celtic penannular brooches. These brooches may be safely dated at not later than 700 A.D., as there is a complete absence of any interlaced ornament on them, and many La Tène elements survive in their decoration, some may even be earlier. They are all of bronze, but the enamels on them have disappeared. Finally, Mr. Coffey contributed a note on the Tara brooch which directed attention to a fact hitherto unobserved, namely, that the fine wires of the interlaced patterns, of the central interlacements and of the head of the pin have a minute granulation, which is not apparent to the naked eye.

Mr. Armstrong's paper directed attention to the recent discovery of a leather shield in co. Longford. The shield is made of a solid piece of leather about 20 inches in length and 19 inches across, and has an oblong central boss, which has been pressed out of the leather and furnished with a cap, composed of finer leather, laced on to the boss. The face of the shield is ornamented with three ribs, between which are small bosses arranged in sets of three, the decoration recalling that of the bronze shields. The back of the shield is furnished with a handle. That the specimen is not the leather lining of a bronze shield is clear from the thickness of the leather and the lacing of the boss. It is of the same type as the bronze shields of Western and Upper Europe.

The subject of earthworks was dealt with by Mr. Goddard Orpen in a paper on the origin of Irish motes, which he referred, on documentary and geographical evidence, not to the Celtic or Scandinavian invaders, but to the Normans, thus bringing the date of their erection down to the eleventh century A.D.

Another paper of considerable interest was Dr. Scharff's, on the Irish horse and its early history. The most complete remains of the horse found in Ireland were discovered in the Craigywarren Crannog, in Antrim. The occupation of this crannog dates back to early Christian times, and the horses were doubtless domesticated. These remains bore as striking a resemblance to the Arab type as does the modern Connemara pony. Other remains found indicate that at a more remote period a small race of horse, similar to those found in the Crannog, lived in Ireland, some of which remains probably belonged to a wild breed. It seems clear that the resemblance of the Connemara pony to the eastern and Libyan horse is not entirely due to human introduction of foreign stock, but to the fact that the wild horse of Ireland possessed the same characteristics, which it transmitted to the existing ancient domestic breeds.

In British prehistoric archæology several important papers were submitted. Miss Layard, whose work on the Ipswich Palæolithic site is well known, directed attention to an ancient land surface in that district, where flint implements have been discovered in association with bones of horse, deer, mammoth, *Bos primigenius*, wolf, and bear. The remains were 30 feet below the present surface. She also directed attention to a new Palæolithic site in the valley of the Lark, where rough palæoliths and a large number of flint cores have been found.

Mr. J. Gray, in a paper on Who built the British stone circles? reported the discovery of the remains of a unique race recently discovered associated with short cists in Aberdeenshire. This race, which is of the early Bronze age, is different from any other known prehistoric race in Britain, Sweden, Denmark, and Switzerland, but there are indications of affinity with the ancient peoples of south-west Asia.

In a paper on cup and ring markings, the Rev. H. J. Dukinfield Astley sought to connect these markings with the designs on the churinga of the Arunta, and suggested that they were totemistic.

A paper by Mr. G. Clinch, suggesting a system of classification of Megalithic remains, and the report of the committee appointed to consider this subject, led to an interesting discussion, in which the president, Mr. Acland, and Mr. Swift MacNeill took part. The general consensus of opinion was that the preservation of ancient monuments should be made compulsory and not merely permissive, and that the inspector of ancient monuments should be an active official with wide powers. It was further suggested that a short private Bill might be introduced into Parliament.

The report of the Glastonbury Lake Village Committee directed attention to the discovery of two other villages at Meare, on which tentative excavations had been made with promising results, while that on the age of stone circles reported that excavations had been begun on the ditch at Avebury, in which were discovered a good stratification of pottery, from Mediæval to Bronze-age types, and deer-horn picks, recalling those of Grime's Graves and Cissbury. These relics tend to confirm the theory that the Avebury circle is of the Neolithic or early Bronze-age period, but this can hardly be said to be proved by the present excavation.

Roman remains in Britain again occupied a considerable part of the section's proceedings. Dr. Ashby again gave an account of the excavations at Caerwent which have resulted in the exploration of the basilica and forum, which corresponds closely to that at Silchester. Dr. Newstead described the portion of Roman wall recently found at Chester. It is of ashlar, backed by rubble, with a solid bank of stiff clayey loam behind. The fosse was also excavated in two places. It was not of the usual V-shape, but was broad at the bottom. The finds were numerous, including portions of pottery, fragments of tiles, bones of animals, and coins. A fine flint axe of Palæolithic type was also discovered, as well as the remains of a quern and some spindle whorls.

Prof. J. L. Myres gave a general account of the work of the Liverpool Committee for Excavation and Research in Wales and the Marches. The last season has been occupied with a preliminary survey of a few districts of Wales, and with tentative excavations on sites which seem likely to deserve more thorough examination. Such was the excavation at Caerleon, an account of which was presented by Mr. H. G. Evelyn White. Its chief importance lay in the recovery of the ground plan of the interior arrangements of the camp.

As is usual, many papers dealing with non-British archæology were presented. Among these, one of the most interesting was Mr. J. P. Droop's, on Neolithic culture in north Greece. One of these Neolithic settlements can be roughly dated to 1300 B.C. by the presence of Mycenæan sherds. Subsequently there was a poor Bronze period. The discovery is therefore of the utmost importance, as it shows that, while the bronze culture of the Ægean was being developed, peoples in the north of Greece were still in the Stone age and used bronze comparatively late, and then, presumably, only for a short period before the introduction of iron.

The excavations on the site of the sanctuary of Artemis Orthia at Sparta were described by Mr. M. S. Thompson. The chief find of the year was the remains of a primitive temple of a date contemporary with the great archaic altar. It seems clear that this had a gable roof with a row of pillars supporting the roof tree, similar to the temple of Thermos in Ætolia. In this primitive building may be seen the earliest Dorian style. Many votive offerings were found on the site, as well as a further number of the terra-cotta masks. The so-called Cyrenaic pottery has been proved to be Laconian, as had already been suggested.

An account of the four principal aqueducts of the city of Rome was given by Dr. T. Ashby. Considerable remains of these conduits still exist. Their course between Gallicano and a point seven miles from Rome, where they run upon arches into the city, has hitherto been treated as unknown, but has now been determined accurately, chiefly by making a search for the pieces of calcareous deposit brought down by the water, which was removed from the channels when they were cleaned. Dr. Ashby also gave an account of the work carried out in Sardinia by Dr. Mackenzie and himself. Their researches were devoted to determining the relations between the nuraghi and the so-called tombs of the giants—the latter consisting of long chambers with a circular area, enclosed by upright slabs or by walling in front of them. It seemed clear that the two were in very close relation, the former being the fortified habitation and the latter the family tomb.

The section was peculiarly fortunate in having a paper presented by Dr. Haakon Schetelig, the director of the Bergen Museum. Dr. Schetelig took as his subject the sculptured stones of Norway and their relations to some British monuments. The symbols on these monuments, for example, the comb, serpent, crescent, and radiated sun-disc, are also found on the early Christian monuments of Scotland, and seem to point to direct communication between Scotland and western Europe about 700 A.D. A sculptured stone from Tu, in Jaederen, with a runic inscription of the peculiar character found on the Norwegian crosses in the Isle of Man, possibly points to an influence from that island.

On non-European archæology four papers were presented. Mr. C. T. Currelly, in a sequence of Egyptian stone implements, considered that the development of the Thebaid palæoliths could be traced from the depth of the patina and from the scratchings. The Neolithic implements of the Thebaid, on the other hand, show little patination, though the length of the Neolithic period may be traced from the fact that unpatinated neoliths have been made by re-working patinated ones.

The Rev. W. A. Adams, in a paper on some ancient stone implement sites in South Africa, recorded the discovery of implements of Palæolithic type from five districts, the hill slope near Bosman's Crossing, Stellenbosch, the Karoo and the Vaal River terraces, near Kimberley, the Rhodesian uplands near Bulawayo, and the headlands of the Victoria Falls.

An interesting paper on prehistoric archæology in Japan was presented by Dr. Gordon Munro, in which considerable light was thrown on the question of the immigrations to the country from the mainland. Many Japanese archæologists deny the fact that the primitive inhabitants of Japan were of the same stock as the existing Ainu, but the discovery of Ainu remains in the shell-heaps proves that this people played a part in the Neolithic culture, and the excavations have revealed a connection between the pottery of this phase and that of the iron culture which accompanied the agricultural invaders from Asia. The progress of these invaders towards the east and north was slow, and may have begun about five centuries B.C., or even earlier. No undoubted Palæolithic remains were found, but the resemblance of the culture to that of other lands agrees with the general verdict of prehistoric intercommunication.

Finally, the Rev. Dr. Bryce, of Winnipeg, read a paper on the mound builders of North America, which was of peculiar interest in view of the association meeting in Winnipeg next year. An examination of a large number of these mounds led the author to conclude that they were built by the Toltecs, and that they mark the course of a Toltec immigration from the south along the Mississippi and Ohio to the Great Lakes and the St. Lawrence; along the Missouri; and along the Mississippi proper to the Rainy and Red rivers. This would make the earliest mound date from about 1100 A.D.

In conclusion, it should be mentioned that the success which attended the meeting was in a very great measure due to the kindness and energy of Mr. Laurence Steele, the section's local secretary.

## LOCAL SCIENTIFIC SOCIETIES AT THE BRITISH ASSOCIATION.

During the Dublin meeting of the British Association the conference of delegates held two meetings under the chairmanship of Prof. H. A. Miers, F.R.S. At the opening meeting, held on September 3, the chairman read an address on the educational opportunities of local scientific societies. In this he reviewed the growth of such bodies, some of which dated back nearly a hundred years. In these cases they did pioneer work, and helped to create a general scientific atmosphere. With the birth of the British Association, which, he said, might be regarded as a magnified society of the same character changing its yearly habitat, a great stimulus was supplied, as at that time scientific work was supplemented in a very inadequate manner by the publishers and the Press. After this date the growth of local scientific societies and cheap elementary text-books, which stimulated a desire for sound knowledge, was very rapid. Gradually, however, the early manuals, containing perhaps a whole science, have been supplanted by the educational text-book used in schools and the specialist treatise for the advanced student. Thus the amateur nowadays is almost in danger of being placed in the position of his predecessor of sixty-five years ago. He has no time to go through a course of special reading in text-books of various grades, and without that, although perhaps quite learned in one branch of science, can get no adequate insight into modern advances through needless technicalities and their expression in a language which he cannot understand.

The same is the case with the greater scientific societies—they are becoming every day more highly specialised, both in their publications and in their membership. Here is the opening for the local scientific society, but only if it really attempts to meet the wants of the intelligent amateur. It is all very well to make arrangements for sections to take up the local flora and fauna, but what is wanted in addition is some common ground by which all the members can be united by their general interest in science, combined with some educational help to those to whom science is chiefly a hobby and a relaxation. One of the most useful functions of a body like a local society is to encourage a habit of expressing scientific result in simple and intelligible language that will appeal to the whole society. Indeed, nothing can be better or more useful for the scientific specialist himself than to attempt to explain his own work in simple language to a mixed audience. The set lecture is not so much needed, but the description by a speaker of what he has done or seen himself. In a local society no better material for educational improvement should exist where the members have joined it voluntarily, and, in the first instance, because they really wished to learn. In addition to this nothing is more wanted at the present day than books giving simple, untechnical accounts of the living work by the worker himself, and this should be done, not only in the newest fields of science, the popularisation of which is liable to be overdone, but in the more ordinary work of everyday science, which results in discoveries perhaps equally momentous, but at present buried beyond the reach of the amateur.

The educational work that the local societies can best perform through its members, who, though not children, have unprepared minds, is the encouragement of original research. This could be done, first, by inviting the trained and experienced workers to make known to them, through the medium of untechnical language, the beauty and interest of scientific work in the course of its progress, and of scientific discovery in the making; and, secondly, by providing them with followers who will continue to prosecute under their guidance original observation and even experimental research. Enthusiasm has been instilled and sincere students produced by the university extension movements; let the local societies initiate a new science extension movement by which the barrier between the professional man of science and the amateur, between the expert and the layman, will be broken down.

After discussion and votes of thanks, Sir Edward Brabrook proposed that "the conference desires to represent to the committee of recommendations that whenever a committee of the British Association enters upon a local investigation, notice should be given to any local scientific or archæological society so as to enable that society to offer any cooperation that may be desirable." This, having been seconded by the Rev. J. O. Bevan, was carried unanimously.

Mrs. Mary Hobson then read a paper on sanctuaries for our native flora and fauna, in which she discussed various schemes for obtaining, or getting public bodies to set aside, waste land as sanctuaries, instancing that in Ireland already such places existed as Lambay Island, protected by the Hon. Cecil Baring; at Glencar, co. Sligo, on land owned by the Wynne family; at Knocknarae Glen, in the same county, where the hartstongue ferns have the longest fronds in Britain, upwards of a yard in length; and, finally, at Clonbrock Forest, in Galway, where Lord Clonbrock has a sanctuary which has been undisturbed since Elizabethan times. She also animadverted especially on the destructive spirit of collecting rare birds and chance migrants, not to speak of other things. That was not the way to advance knowledge, which was, however, fostered by the study of birds in their native haunts.

In the discussion on this paper several delegates took part. Mr. W. M. Webb, of the Selborne Society, gave some particulars about a sanctuary in which his society was interested. He also agreed that private collecting, if done at all, should be started with the idea of benefiting the many instead of the few. Mr. William Gray, of the Belfast Naturalists' Field Club, spoke as to the destruction by collectors of the eggs of rare birds, which would breed if they were not disturbed, and how last season the club, through providing a watcher, had been successful in the case of a previously much harried species. Mr. J. Hopkinson mentioned that public bodies sometimes were gross offenders in their demands for large numbers of some rare plant from a local habitat, while the Rev. Ashington Bullen spoke as to the scarcity or extinction in certain haunts of species that were formerly plentiful. Mr. Harold Wager thought that the local societies could do much by encouraging a more scientific attitude towards collecting and by inducing a study of the habits and life-histories of the living organism in the field.

The second meeting of the conference of delegates was held on September 8, and was presided over, in the absence of Prof. Miers, by Prof. Grenville A. J. Cole, vice-chairman. At this meeting Prof. G. H. Carpenter introduced the subject of detailed natural-history surveys of restricted areas, an important work suitable for local societies. In his remarks he described the researches lately carried out into the natural history of the island of Lambay, off the coast of co. Dublin, and what was being done at the present time on the North Bull, a grass-covered sandbank in Dublin Bay, known to be less than a century old. Prof. Carpenter urged the importance of the study of such restricted areas as likely to help in the solution of many geographical problems. Several delegates having spoken, Mr. Frederick Long, of the Norfolk and Norwich Naturalists' Society, directed attention to the fact that a few years ago Mr. Robert Gurney established a small laboratory on Sutton Broad, in Norfolk, for the use of anyone wishing to prosecute research work in that area.

Mr. Henry Davey then read his paper on the advisability of re-stocking haunts whence fauna and flora have disappeared. His main contention was that in the case of many of the rarer Lepidoptera, with which alone he was thoroughly familiar, their disappearance or extinction was not so much due to man, but to natural causes, the reason of which in most cases had not yet been discovered. He instanced the case of the large copper, which disappeared in one locality through man, but in the other from no such cause, although he mentioned that a great fen-fire had been blamed. As for the growing rarity of many species, he thought that much destruction was caused by the ease with which the present-day collector was able to get about, but, speaking of the large blue—*Lycaena arion*—which had been killed off in most of its localities, he said that while collectors had caused its extinction at Barnwell Wold, its favourite habitat, it had also disappeared from another resort in Northamptonshire to which the public had no access. Of this insect also he mentioned Mr. Frohawk's discovery in 1903, at its breeding ground in Cornwall, of the caterpillars living on thyme growing on or near ant hills, into which the full-grown larvae descended so that the ants might remove a secretion which seemed deleterious to their health. As to re-stocking, he considered that it was of little value in the present state of our knowledge. The swallow-tailed butterfly, which in England is now restricted to a small area in the fens, from his observation on the Continent seemed to flourish among or near wooded hills, and never in the flats. However, no success resulted from the attempt to establish it on a large scale in the Peak of Derbyshire and in Devonshire.

Again, an insect which may be far from rare, in certain spots favours such a small area that it may be measured by yards, notably a locality in Sussex, where the marbled white is extremely common in a tract about eighty yards square. Again, in the case of the clouded yellows, in some years the two species may be exceedingly abundant; in the intermediate time not a specimen is to be seen. In such a case re-stocking would be of no use, while the disappearance of the insects has not been caused by man. Finally, Mr. Davey considered that, on the whole, the experiment of re-stocking former haunts was worth the attempt, although from what he had mentioned success was not assured. Such work ought to be undertaken, however, in a scientific spirit, and exact records should be kept. It was also highly desirable that the re-stocking should be tried in two places at the same time a few miles apart, and that individuals should be brought from different localities to avoid, so far as possible, the danger of in-breeding.

Prof. Carpenter during the discussion directed attention to the fact that the species that tended to become extinct were those of commercial value, while Prof. Cole thought that stocking localities with species that had not previously lived there would nullify much of the work on their natural distribution. Under the head of the introduction of insects to localities where they had become extinct or were becoming scarce, Mr. W. P. Stebbing directed attention to what was being done by Mr. Henry Preston, of Grantham. He had collected a large number of the caterpillars of the Peacock butterfly from clumps of nettles, which were always destroyed by the farmers before the insects were full grown, had kept them until they turned into chrysalises, and then on emerging as perfect insects had turned them loose in seemingly suitable spots.

Arising out of the previous papers, the Rev. J. O. Bevan brought forward the following resolution:—"That this Conference of Delegates of Corresponding Societies affirms the desirability of bringing under the notice of local societies the necessity for preserving the fauna and flora of their respective districts as against wanton destruction or careless and needless collecting." This was seconded by Mrs. Hobson, and carried unanimously.

At the close of the meeting Mr. F. A. Bellamy (Ashmolean Natural History Society of Oxfordshire), who had had his notes printed as a paper for distribution to the meeting, exhibited his method for the permanent recording of natural history or other observations by means of the card-catalogue system. In explaining the value to workers of such a catalogue, he said that care was needed when outlining such a scheme so that it would retain its usefulness whatever the size. He also gave an estimate of the cost of one unit (tray, cards, and cover) of the catalogue.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—At the annual general meeting of the Philosophical Society, held on October 26, Prof. Sedgwick was elected president of the society.

It is proposed to confer the degree of Master of Arts, *honoris causa*, upon Prof. W. J. Pope, F.R.S., professor of chemistry, and upon Mr. K. J. J. Mackenzie, lecturer in agriculture.

Mr. R. C. Punnett has been appointed demonstrator of animal morphology for the year ending Michaelmas, 1909, and Mr. F. H. Potts demonstrator of comparative anatomy.

LONDON.—Prof. E. A. Minchin will represent the University at the Darwin centenary celebration at Cambridge next June.

At the meeting of the Senate on October 21 the degree of D.Sc. was granted to David Forsyth, of Guy's Hospital, as an internal student, for a thesis entitled "The Parathyroid Glands"; to Samuel J. M. Auld, of East London College, as an internal student, for a thesis entitled "The Hydrolysis of Amygdalin by Emulsin"; to Henry Bassett, an external student, for a thesis entitled "Contributions to the Study of the Calcium Phosphates"; and the degree of B.Sc. by research to Joseph Yates, Municipal Technical School, Blackburn, an external student, for research work in organic chemistry.

A university course of eight lectures on "Some Problems of General Physiology, more Particularly those Associated with Muscle," was commenced by Dr. F. S. Locke, in the physiology laboratory of the University, on October 20. A university course of three lectures by Mr. R. Lyddeker, F.R.S., on "The Living and Extinct Faunas of Africa and South America," commenced on October 28 at University College. A university course of eight lectures on "Algal Flagellates," by Dr. F. E. Fritsch, commenced at University College on October 26. Admission to these lectures is free to the public.

Oxford.—Prof. C. F. Jenkin, professor of engineering in the University, delivered his inaugural address on October 16. No teaching, he said, is sufficient to fit a man for an engineer's various duties. The scientific theory of engineering can be taught, but the no less necessary experience must be gained outside the university. Prof. Jenkin described the teaching of engineering, showing that while the subjects are familiar, the engineering method of teaching differs somewhat from the traditional method. He advocated the use of examples chosen from apparatus which the student can handle rather than from the imaginary astronomical bodies often used to illustrate dynamical principles. In the Oxford laboratory the art of measurement will be taught. It will not be a model shop, but a shop may be used in conjunction with the laboratory for repairing and adjusting apparatus. It is also intended to have surveying classes during the vacation. Prof. Jenkin also explained the details of the scheme which has been prepared for carrying out engineering teaching in Oxford. It is intended that engineering students shall take the science preliminary examination and then proceed to a final honour school in engineering. The necessity for having a final honour school for the student to work for was urged, and there is every reason to believe that the scheme now being prepared will be received favourably, and thus open academic honours to engineers.

The Right Hon. A. J. Balfour, F.R.S., M.P., has been nominated by the Vice-Chancellor to deliver the Romanes lecture next year.

Dr. A. J. Evans, F.R.S., will resign the keepership of the Ashmolean Museum at the end of this year.

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We have received from Prof. W. S. Franklin, of Lehigh University, a copy of the address he delivered at the annual meeting of the New York State Science Teachers' Association last year on the study of science by young people. In it he stigmatises as one of the greatest evils of present-day teaching of science the large proportion of time devoted to problems more or less completely detached from actual physical experience. He believes that the only quantitative physical laboratory work which should be done in a secondary school should relate to things of which the boy has knowledge in his everyday life outside the laboratory, and should be of practical value in that life. Thus, *e.g.*, he would let a boy determine the speed of a runner by observing the time he takes to cover a measured distance, or the power he develops by the time he takes to climb a measured flight of stairs. He would set him to determine the discharge of water along a canal by timing a float from one station to another, and encourage him to measure the rainfall, record temperature, wind and cloud, and get together a great variety of similar data of practical everyday value.

The Association of Teachers in Technical Institutions has forwarded to the Board of Education a memorandum directing attention to the conditions under which Whitworth scholarships and exhibitions are awarded. The council of the association has, after extensive inquiries, been led to the conclusion that the competitions at present are not in full accord with modern requirements of engineering study and training, and it has, in consequence, drawn up proposals for the modification of the methods of award. The objects of the proposals are to prevent cram and to provide systematic training, to give preference to engineering subjects, to encourage regular workshop practice in engineering over a period of thirty-six months, and to ensure greater prominence for study and practice in electrical engineering. Among other changes suggested are the introduction of a qualifying test, the holding of a special freehand drawing examination, the division of subjects into two groups and a new scale of marks, and the deletion of building construction and drawing and naval architecture from the list of subjects candidates may offer, as not strictly belonging to mechanical engineering. The annual general meeting of the association will be held at the St. Bride's Institute, Bride Lane, Fleet Street, E.C., on Saturday, November 7, commencing at 3 p.m.

The *Physikalische Zeitschrift* for October 15 contains a list of the lectures in mathematics, physics, and chemistry which are to be delivered during the coming winter session at the various universities and technical high schools of Germany and Austria. At the University of Berlin each of the above subjects is divided into ten or a dozen parts, and each part is placed under the charge of a separate professor or lecturer, who gives four or five lectures per week. Physics, for example, is divided into (*a*) experimental physics: (1) mechanics, sound, and heat; (2) magnetism and electricity; (*b*) theoretical physics: (3) introduction; (4) heat; (5) magnetism and electricity; (6) advanced portions; (7) vector analysis applied to physics; (8) potential theory; (*c*) (9) geophysics; (10) climatology. Under such a system it is possible for each lecturer to present his subject to his students in a much more complete and up-to-date manner than is possible in, let us say, the University of London, the professors of physics of which lecture probably twice as often per week and cover the whole subject in their lectures. Who in these circumstances can blame the post-graduate student who elects to go to Germany to complete his knowledge of his subject? and who can refrain from asking, when will the universities of this country be in a position to attract post-graduate students from Germany in return?

## SOCIETIES AND ACADEMIES.

### Paris.

**Academy of Sciences**, October 19.—M. Bouchard in the chair.—Precipitated silica: Henry **Le Chatelier.** The existence of hydrated forms of silica appears to be generally admitted, but this view does not appear to have any experimental basis. Various experiments with gelatinous silica are described, all tending to prove that silica exists always in the anhydrous state. The passage through filters is not due to the solubility of anhydrous silica or the presence of a soluble hydrate, but is due to its extremely fine state of division. In confirmation of this, it was found that silica jelly could be used for polishing metal sections.—The influence of the heating of urine on urinary toxicity: Ch. **Bouchard,** M. **Balthazard,** and Jean **Camus.** After heating urine to temperatures of 57° C. or above, the toxic power is diminished by one-third, as measured by experiments on rabbits. The freezing point of the urine is not affected by this heating.—The action of Saturn's ring: P. **Stroobant.**—The spectrum of Morehouse's comet, 1908*c*: A de la Baume **Pluvinel** and F. **Baldet.** A comparison of the spectra of the Daniel and Morehouse comets. The latter gives no trace of a continuous spectrum; the photograph shows seven monochromatic images of the comet, the wave-lengths of which are given.—Some properties of curved surfaces: A. **Demoulin.**—Directed waves in wireless telegraphy: A. **Blondel.** Referring to recent papers on this subject by MM. Tosi and Bellini, and by M. Turpain, the author points out that he dealt with this subject in a similar manner in 1903.—The electrolytic soda industry: André **Brochet.** A theoretical discussion of the electrolytic cell through which the electrolyte is flowing in a stream with a velocity equal to or greater than the velocity of the OH ions.—A new method of attacking iron alloys, and, in particular, the ferrosilicons: Paul **Nicolardot.** Chloride of sulphur is the reagent suggested for the solution of ferrosilicons or ferrotitaniums. Details are given of the method proposed, which is specially arranged to avoid loss of silicon.—The phenyl transposition. The migration of the naphthyl group in the iodohydrins of the naphthalene series: MM. **Tiffeneau** and **Daudel.** The migration of groups caused by the addition of hypoiodous acid and subsequent removal of hydriodic acid has been found to occur in the naphthalene series in a manner quite analogous to that previously described for the benzene series. Descriptions are given of the preparation and properties of α-allylnaphthalene, its isomer, propenylnaphthalene, α-naphthyl-α-propanal, methyl-α-naphthylacetic acid, α-pseudoallylnaphthalene, α-vinylnaphthalene, and α-naphthylethanal.—A modification of the preparation of methylamine by means of bromacetamide: Maurice **François.** It has been found advantageous to modify the original Hoffman method in several details.

The yield is increased from 35 per cent. to 72 per cent. of the theoretical, and the methylamine hydrochloride is obtained pure and free from ammonium chloride.—The study of colouring matters in solution: L. **Pelet-Jolivet** and A. **Wild.** Colouring matters exist in a state of electrolytic dissociation; some of them are partly in the colloidal state, as was shown by their behaviour in the ultramicroscope. The properties of colouring matters are intermediate between ordinary saline solutions and colloidal solutions.—Saprophytic cultures of *Cuscuta monogyna*: Marin **Molliard.**—The Secamone of the north-west of Africa: Henri **Jumelle** and H. Perrier **de la Bathie.**—Pigmentary assimilation in Actinia: Georges **Bohn.**—The hereditary chromatic substratum and the nuclear combinations in the crossing of Amphibia: E. **Bataillon.**—The gradation and improvement of the instinct in the solitary wasps of Africa of the genus Synagris: E. **Roubaud.**—The affection known under the name of botryomycosis and its parasite: Gustave **Bureau** and Alphonse **Labbé.** This disease is not a mycosis, but is due to an amœba; the botryomyces observed in previous cases is only a plastogamic stage of this organism.—The protonephridia of the adult polychætal annelids: A. **Malaquin.**—The existing genera of the family of the brachypodides: A. **Menegaux.**—New researches on the radio-activity of springs producing goitre: M. **Répin.** All the goitre-producing waters of the Alps gave on examination a measurable radio-activity, due probably to radio-thorium.—The accelerative influence of magnesia in the transformation of saccharose: J. **Tribot.** Sucrase was prepared from yeast and purified by fractional precipitation with alcohol. It was found that the purer the product from mineral matter the smaller was the activity, as measured by the amount of sugar fermented in a given time. The mineral substance to which the activity would appear to be due is magnesia.—The ferment from the decapod Crustacea: C. **Gerber.** This ferment is distinguished from other animal ferments by its resistance to heat and by the special action of acids. Its properties approach those of the vegetable ferments.—The numerical determination of the urinary excretion of nitrogen in various forms in a normal man: L. C. **Maillard.**—The action of the products of the reaction on the saponification of fats by the pancreatic juice: Mlle. L. **Kalaboukoff** and Émile **Terroine.**—The tonality of the sound of percussion: Gabriel **Arthaud.**—The existence of a new deposit of pre-Pyrenean strata in the middle of the north Pyrenees sheets, in the neighbourhood of Arbas: Léon **Bertrand.**—The seismic disturbance of October 13, 1908: Alfred **Angot.** A discussion of the seismograph record at the Parc Saint-Maur Observatory.—The erosion of the Fontainebleau grits: E. A. **Martel.**—The presence of the genera Salvinia, Nymphæa, and Pontederia in the sparnacian clays of the Montois: P. H. **Fritel.**

## DIARY OF SOCIETIES.

*FRIDAY*, OCTOBER 30.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Repairs, Renewals, Deterioration and Depreciation of Workshop Plant and Machinery (*Resumed discussion*): J. E. Darbishire.

*MONDAY*, NOVEMBER 2.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Unexplored Western Asia: D. G. Hogarth.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Chemical Industry in Relation to Agriculture: Prof. Adolf Frank.

*TUESDAY*, NOVEMBER 3.

ZOOLOGICAL SOCIETY, at 8.30.—The Development of the Lesser Black-backed Gull, *Larus fuscus*, L.: Prof. Alexander Meek.—On Mammals from Inkerman, North Queensland, presented to the National Museum by Sir W. Ingram and the Hon John Forrest: Oldfield Thomas, F.R.S., and Guy Dollman.—(1) The Sze-chuen and Bhutan Takins: (2) On an Indian Dolphin and Porpoise: R. Lydekker, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Address by the President, Mr. J. C. Inglis.

*WEDNESDAY*, NOVEMBER 4.

ENTOMOLOGICAL SOCIETY, at 8

GEOLOGICAL SOCIETY, at 8.—The Relations of the Nubian Sandstone and the Crystalline Rocks of Egypt: H. J. L. Beadnell.—On the Fossil Plants of the Waldershare and Fredville Series of the Kent Coalfield: E. A. Newell Arber.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Solvent Action of Carbonic Acid on the Carbonates of the Heavy Metals: C. Seyler.—The Analysis of Camphorated Oil for Camphor Substitutes: F. W. Richardson and W. K. Walton.—The Separation and Estimation of Certain Volatile Fatty Acids by Extraction with Benzene or Toluene: T. R. Hodgson.—The Estimation of Cocoanut Oil in Butter: R. Ross.

*THURSDAY*, NOVEMBER 5.

ROYAL SOCIETY, at 4.30.—*Probable Papers.* (1) Note on Tidal Bores; (2) Vortices in Oscillating Liquid: Lord Rayleigh, O.M., Pres. R.S.—Note on Two recently-compiled Calendars of Papers of the period 1606–1806 in the Archives of the Royal Society: Prof. A. H. Church, F.R.S.—On the Osmotic Pressures of Aqueous Solutions of Calcium Ferrocyanide. Part I., Concentrated Solutions: Earl of Berkeley, F.R.S., E. G. J. Hartley, and C. V. Burton.—On the Generation of a Luminous Glow in an Exhausted Receiver moving near an Electrostatic Field, and the Action of a Magnetic Field on the Glow so produced, the Residual Gases being Oxygen, Hydrogen, Neon and Air: Rev. F. J. Jervis-Smith, F.R.S.—The Rate of Production of Helium from Radium: Sir James Dewar, F.R.S.—The Spectrum of Radium Emanation: A. T. Cameron and Sir William Ramsay, K.C.B., F.R.S.—On a Method of Comparing Mutual Inductance and Resistance by the Help of Two-phase Alternating Currents: A. Campbell.—The Effect of Pressure upon Arc Spectra. No. 2, Copper: W. G. Duffield.

CHEMICAL SOCIETY, at 8.30.—The Direct Union of Carbon and Hydrogen: W. A. Bone and H. F. Coward.—The Relation between Absorption Spectra and Chemical Constitution. Part XI, Some Aromatic Hydrocarbons: E. C. C. Baly and W. B. Tuck.—Organic Derivatives of Silicon. Part VII., Synthesis of *dl*-Sulphobenzylethylisobutylsilicyl Oxide: B. D. W. Luff and F. S. Kipping.—(1) Chlorine Derivatives of Pyridine. Part IX, Preparation and Orientation of the Dichlor pyridine, m. p. 66–70°; (2) Chlorine Derivatives of Pyridine. Part X, Orientation of the Trichloropyridine, m. p. 49–50; (3) Chlorination of Methyl Derivatives of Pyridine. 2-Methyl pyridine. Part II.: W. J. Sell.—(1) The Triazo-group. Part V., Resolution of *a*-Triazopropionic acid; (2) The Triazo-group. Part VI., Triazoethyl Alcohol and Triazoacetaldehyde: M. O. Forster and H. E. Fierz.

LINNEAN SOCIETY, at 8.—Notes on some Parasitic Copepoda, with a Description of a New Species of *Chondracanthus*: May E. Bainbridge.—On some Nemerteans from the Eastern Indian Ocean: R. C. Punnett and C. Forster Cooper.—Report on the Echinoderms other than Holothurians collected by Mr. Stanley Gardiner in the Western Parts of the Indian Ocean: Prof. F. Jeffrey Bell.

RÖNTGEN SOCIETY, at 8.15.—Presidential Address, The Amsterdam Congress.

*FRIDAY*, NOVEMBER 6.

GEOLOGISTS' ASSOCIATION, at 8.—On some Norwegian Lakes and Rock-Basins: H. W. Monckton.

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